MUNICIPAL ENGINEERING

The World's Leading Municipal Publication.

WOOD BLOCK PAVING ON HEAVY TRAFFIC BUSINESS STREET.

VOL. XLVII. NOVEMBER, 1914. NO. 5.

I'm now arrived—thanks to the gods!—
Thru pathways rough and muddy,
A certain sign that makin' roads
Is no' this people's study;
Altho I'm not wi' Scripture cram'd,
I'm sure the Bible says
That heedless sinners shall be damn'd
Unless they mend their ways.

—ROBERT BURNS.

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AMERICAN SOCIETY *of* MUNICIPAL IMPROVEMENTS

ABSTRACTS OF PAPERS PRESENTED AT THE OCTOBER CONVENTION AT BOSTON.

So many excellent papers were read at the convention of the American Society of Municipal Improvements that it is impossible to use them all or all of any considerable part of them in this number of MUNICIPAL ENGINEERING. *The selections made are grouped together and show the breadth of the field covered. All of the proceedings will appear in the annual volume published by the Society.*

Inflammable Wastes in Sewers.

By N. S. Sprague, Superintendent of Construction, Pittsburgh, Pa.

There have been many explosions in sewers in recent years, of but few of which definite information is available. Pittsburg has had its full share of serious troubles of this sort and the author has made a careful study of the subject. The results of his inquiries of other cities are given in a pamphlet printed by his department, and the application of the information gained to the problem of prevention of explosions is given in this paper.

THE author presents this paper with the hope of eliciting discussion upon this subject by those charged with the responsibility of the design, maintenance and operation of sewerage works, which may throw some light upon the ultimate solution of the problem of regulating the discharge of inflammable and explosive wastes into sewerage systems and preventing sewer explosions.

It is thought that some of the more recent and violent explosions were caused by the presence of gasoline vapor in the sewer and if this belief is accepted as a fact, then the advent of motor driven vehicles has created a problem in sewer design and maintenance which may prove difficult and expensive to solve. Sewer systems are generally looked upon by the average person as a quick and easy means of disposing of any or all waste matter which can be carried away by the sewer without any consideration whatsoever of the effect of such discharge, either upon the structure itself, its maintenance or operation. The transition in the mode of travel from horse-driven vehicles to the motor-driven car and truck, renders the transportation, handling and use of large quantities of gasoline necessary and it is inevitable that in the handling of this material some will be spilled or wasted, either by accident or design, which will find its way into the sewers.

There are many sources which contribute inflammable wastes in a greater

or less degree, ranging from the small and irregular discharges from households and private garages, which may amount to considerable in the aggregate, to the large and intermittent discharges from manufacturing and storage plants and other enterprises which use large quantities of gasoline.

In some cities (Pittsburg included), the laws relating to the storage of gasoline require the tanks to be buried in the ground. These tanks, which are made of riveted steel plates, vary in capacity from about 50 to 15,000 gallons. The purpose of placing them underground is to prevent possible ignition of the gas and protect them in case of a nearby fire. It is not the author's intention to discuss the advisability or the objection to placing gasoline storage tanks underground, but simply to point out the possible danger of gasoline escaping from these tanks and entering the sewers. The thickness of the steel plates of which the tanks are made, is generally from ⅛ to 3/16-inch and their only protection from corrosion is the application of ordinary structural paint. The tanks are laid directly upon the ground and then covered with earth. Under such conditions, corrosion is rapid. It is also possible, under favorable conditions, that the tanks may suffer injury due to electrolytic action. In any case, there is no opportunity for inspection or repairs and leaks can only be detected by making a comparison of the quantity of gasoline put into the tank with the quantity removed. This information is in the possession of the owners and in case a leak is disclosed by a comparison of the figures, the owners are not likely to volunteer the information to the public authorities.

¶ LEAKAGE *from underground sheet metal gasoline tanks is certain. That this leakage will reach near-by sewers is quite probable.*

The possibility of gasoline escaping from the tanks into the ground and finding its way into the sewers, may be remote, but with pervious soil or a near-by catch basin or trap, the opportunity for leakage into the sewers is at least present. In certain locations it is quite possible to set these tanks above ground, where ample opportunity for inspection and repairs would be possible. The waste gasoline from households, private garages and shops, is so well distributed thruout the lateral sewer system and the average amount discharged at any one time so small, that it is quickly dissipated before the formation of explosive vapors can occur. It is, therefore, to be supposed that the formation of gasoline vapor and other explosive gases present in sewers originates from establishments which are large users or dealers in inflammable materials.

There being in most cases no laws prohibiting the discharge of inflammable wastes into the sewers and the danger of such practice not generally understood, the natural disposition of such wastes is into the sewers. Those wastes comprise dirty and used gasoline, benzine, oil, washings from tanks, and refuse from gas plants, paint works, etc. The quantity of these waste products varies according to the magnitude of business and methods employed.

¶ WASTE PRODUCTS *of other kinds than gasoline may produce explosions and they must be regulated also.*

While the discharge of gasoline into the public sewers probably exceeds in quantity any other inflammable waste, yet the discharge of waste products from paint works, oil refineries, gas works, etc., is likely to produce conditions, which, under favorable circumstances, may fill the sewer with explosive gas. Ignition of explosive gases, when present in the sewers, may occur in many different ways—for instance: Sparks from street railway tracks, hot cinders and sparks from locomotives, stacks, etc., which may enter the manholes thru the perforations in the covers, or when same are removed for inspection or repairs; also the dropping of matches or lighted cigars into manholes or catch basins; lights and sparks from tools, while making inspection or repairs within the sewer or at chambers, pumping stations or disposal plants.

The problem of preventing sewer explo-

sions would then seem to be a question of either effectually sealing all openings into sewers or excluding or regulating the discharge of inflammable or explosive wastes.

A number of cities have attempted to solve the problem by procuring legislation prohibiting or regulating the discharge of inflammable waste materials into the sewers. Prior to the general use of motor vehicles there were many industrial and business establishments using inflammable and volatile wastes, such as dry cleaning establishments, paint manufactories, gas works, etc. Notwithstanding the fact, explosions in sewers caused by the ignition of gasoline vapor were uncommon. This fact would seem to indicate that the greatly increased use of gasoline due to the growth of the automobile industry has been responsible for many of the recent sewer explosions.

¶ CONTROL OF DISCHARGE *of gasoline into sewers is easy if from large sources, difficut if from many small sources.*

Accepting this theory as a working basis, we must determine whether or not the gasoline is discharging into the sewers in large quantities by a relatively few people or in small quantities by a great number. In the first case the situation is relatively easy to control, while in the latter, it would be difficult. Moreover, it is necessary and important to determine whether the explosive vapor is generated from the accumulative effect of a great number of small discharges or from the discharge of large doses. Past experience has shown that the ordinary means of providing ventilation in sewerage systems has been generally adequate to prevent the collection of explosive gases. If large doses of inflammable wastes are allowed to enter the sewers, other means of ventilation will have to be provided or the sewers sealed. The installation of mechanical ventilation in the sewers thruout the system would remove the gases, but would involve great initial outlay and the cost of maintenance and operation would generally be prohibitive. This scheme would not seem practicable. There is no practical way of providing sufficient ventilation, either by mechanical or natural means, which would exhaust the air inside the sewer quickly enough to prevent the formation of an explosive compound, in case large quantities of gasoline were present in the sewer. With the exclusion of large discharges of gasoline into the sewers, the danger of explosions can be greatly lessened by giving more attention to the improvement of the natural ventilation. This would probably be sufficient to prevent the collection of explosive vapors arising from the normal amount of gasoline discharged into the sewers. To form an explosive mixture a certain amount of air and gas is required. If there is a shortage of gas or an excess of air, no explosion can occur.

It cannot be ignored that many sewer explosions have resulted from the leakage of natural or artificial gas into the sewers. Evidence has been conclusive, in a sufficient number of cases, to show unmistakably that this is a fact. The prevention of explosions from this source, however, is well within the jurisdiction of public officials and the remedy is the tight construction of sewers and proper laying and location of gas pipes. The remedy in this case consists, therefore, is in the enforcement of powers that municipalities at present possess.

¶ VENTILATION *and inspection are aids, but so far have been insufficient to control the situation.*

Modern sewer design provides for the ventilation and inspection of the structure. The discharge of inflammable wastes into sewer systems would not of itself be a serious matter, or objectionable, were it not for the possibilities or igniting the explosive compounds. Ignition of gases in the sewers could be prevented by sealing all openings, but this would prevent inspection and create impossible working conditions inside the sewer when repairs became necessary. Moreover, the sealing of the sewers would not prevent ignition at chambers, pumping stations and disposal plants. In addition to the foregoing, there are other reasons which would make

the sealing of the sewers impracticable and inadvisable.

The exclusion of inflammable wastes from a sewer system brings up the question of how it shall be accomplished. The regulations of the Municipal Explosives Commission of the city of New York, adopted January 3, 1912, require the installation of oil separator traps or similar apparatus. The city of Boston requires a special trap which will prevent the discharge of the objectionable wastes into the sewers, and the city of Chicago has somewhat similar regulations to those of New York, governing this matter.

The efficiency of these devices is dependent upon the attention paid to their operation by the individual. Careless operation or neglect might render them of little value and defeat the purpose for which they were installed. Therefore, frequent inspection should be made by the proper public officers. Their general use on all sewer connections where gasoline or other inflammable waste is discharged would seem prohibitive, if found otherwise advisable, on account of the cost. The compulsory installation of devices for removing oil will generally meet with opposition by those affected, which has been recently demonstrated by the passage of an ordinance in New York City repealing the ordinance requiring the installation of oil separators. I am informed that this repealing ordinance was vetoed by the Mayor.

¶ LEGISLATION *on the subject must be most carefully formulated if it is to be effective.*

Formulation of legislation directed toward the prohibition of the discharge of inflammable wastes into sewers is at present receiving attention in many cities. That the same may be effectual requires the most careful consideration. It is most desirable that the necessity for such regulations be demonstrated and the efficiency of any device thoroly proven before they are required by ordinance.

The writer has examined the regulations of a number of cities and has come to the conclusion that it would be best from the standpoint of enforcement, to have all regulations of this nature contained in a single ordinance which would cover all phases of the discharge of wastes of all descriptions into the sewers. Such an ordinance should contain the following:

¶ GENERAL PROVISIONS *of ordinances designed to prevent sewer explosions are briefly stated.*

A. Prohibition against the discharge of any inflammable gas, volatile inflammable liquid, inflammable liquid, oil or gas, or any calcium carbide or residue therefrom, or any liquid or other material or substance containing inflammable gas or which would evolve an inflammable gas when in contact with water or sewage.

B. Regulations as to how sewer connections with establishments from which the foregoing wastes emanate may be made. This may, or may not, require the installation of special traps, separators or similar devices.

C. Provision for the examination and approval of all intercepting devices and provision for their inspection, maintenance and operation.

D. Provision with regard to the discharge or placing of obstructing material in any part of the sewer system.

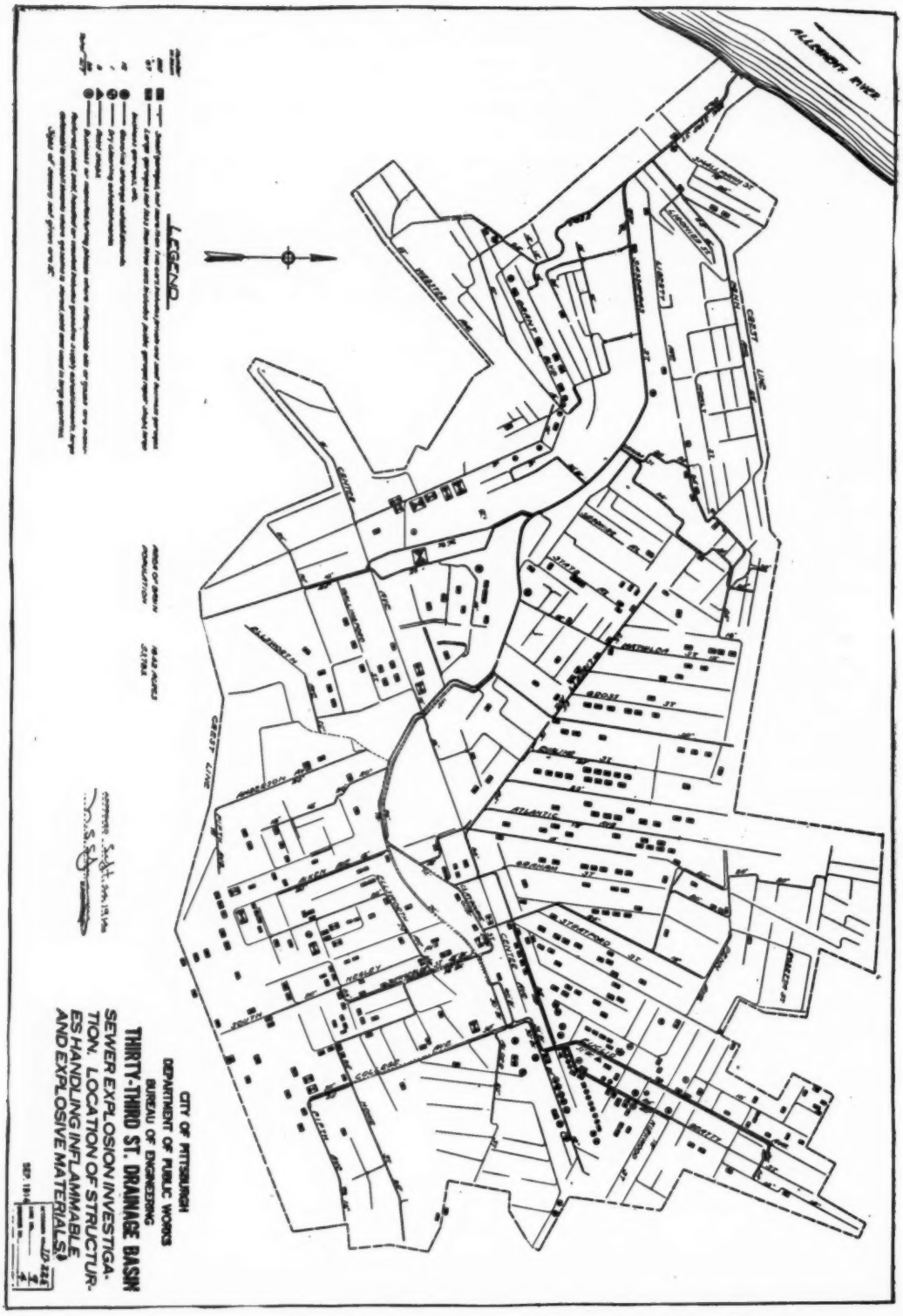
E. Regulations as to the discharge of steam or hot liquid or gaseous waste into the sewers.

F. Regulating the location of gas pipe in city streets with reference to the sewer; prohibiting the placing of gas pipes close to or within the masonry of sewers.

G. Prohibiting connections from manholes, gate boxes, or other apparatus of public service corporations to the sewers, except in an approved manner and when properly trapped.

Legislation alone will not secure or prevent the discharge of these objectionable wastes into sewer systems, but by informing the people of the damage resulting from this pracice, the offense will be greatly lessened.

It would appear desirable, in the interest of public safety, where oil separators or similar devices are installed, for the



November, 1914

municipality to undertake the final disposition of the residue rather than entrust it to the individual. The importance of the problem and the necessity for its strict and effectual regulation has been amply and forcefully demonstrated by recent violent and destructive explosions.

¶ SERIOUS EXPLOSIONS *in Pittsburg sewers have occurred in the past year, and others in other cities are only less serious and less expensive.*

As recently as September 22, another serious explosion occurred in Pittsburg in the sewer on East 42nd street, between Third avenue and the East river, making the third explosion in the same sewer within a year. Reports state that the physical damage to the sewer, buildings and street, was not extensive. This is accounted for by the fact that the sewer was a brick lined tunnel in rock about forty feet below the street surface. Under less favorable conditions of location and design this result would have been far more serious.

The most disastrous and expensive sewer explosion up to the present time, altho entailing no loss of life, occurred at Pittsburgh, Pa., November 25, 1913. This explosion to date has cost the city about $300,000, which may be increased by possible damage suits.

This problem is not confined to the prevention of explosions in the sewers themselves, but may extend to all kinds of sewerage works, as shown by the explosion in the screen chamber at East Boston, which occurred June 1st, of this year. In this explosion, which was caused by the presence of gasoline vapor, six lives were lost and three men severely injured.

Without mention of other recent sewer explosions, it is evident from experience covering many cities, that an immediate, effectual and permanent remedy must be found to control the situation. With three explosions in the 42nd street sewer in New York and two in the 33rd street sewer in Pittsburgh, all within less than a year of each other, there can be no question but what the conditions inside of all large sewers draining garages, etc., are such as to produce explosions whenever ignition occurs. The safety of the public and the welfare of the community are, therefore, now dependent more upon good fortune than the certainty of scientific control, hence the public is always exposed to the hidden danger which only requires a chance spark to cause havoc and disaster. The present situation can be likened to the man sitting on a key of powder.

¶ INVESTIGATIONS *with a view to future prevention are now in process by the city and the U. S. Bureau of Mines.*

The city of Pittsburgh, immediately after the second explosion, set about to make an investigation and study with a view of preventing a repetition of such disasters. This investigation is being conducted jointly by the city and the local office of the U. S. Bureau of Mines, who have rendered valuable assistance and advice.

The purpose of this investigation, which is still in progress, is:

First. To locate all possible sources from which gasoline or other explosive wastes might enter the sewers.

Second. To determine, by a series of examinations and tests, the location of the sources where the waste was discharged.

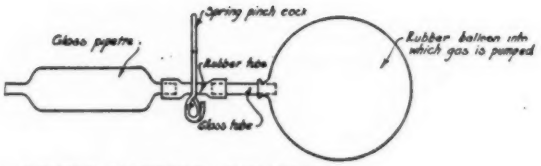
Third. The determination of the presence, extent and quantity of vapor within the sewers.

Fourth. Experiments to determine the effect and behavior of gasoline dumped into the sewer in different quantities and at different intervals.

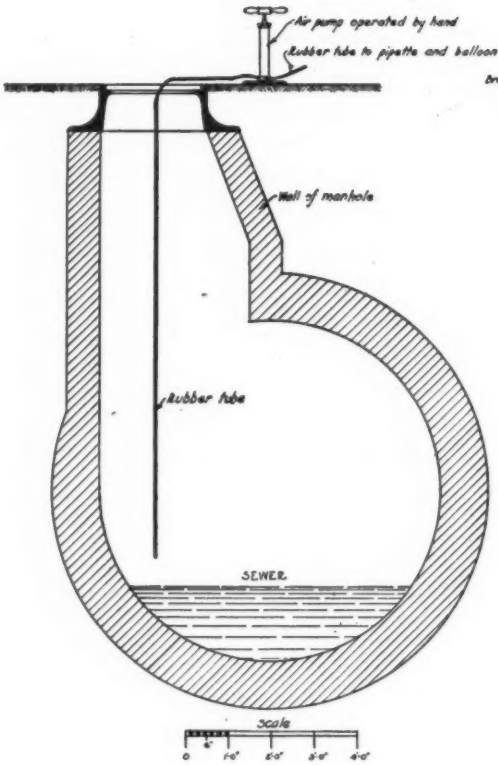
The 33rd street drainage basin was selected for study because of the number of garages within the basin and the fact that two explosions have already occurred, indicating the discharge of large quantities of explosive waste into the sewer.

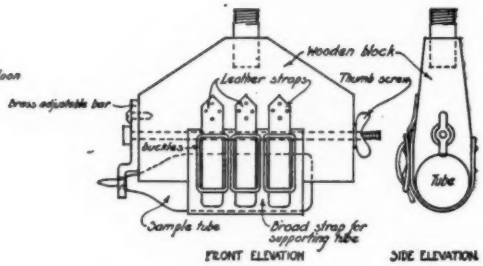
The 33rd street drainage basin has an area of 1,642 acres, a population of 53,785, and a total of 417 structures where inflammable and explosive materials are handled. These structures are classified as folows:

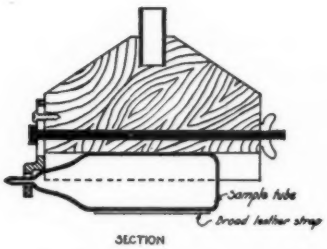
Two hundred ninety-five small garages,



SKETCH OF PIPETTE AND BALLOON
scale







SKETCH OF APPARATUS FOR COLLECTING GAS SAMPLES FOR ANALYSIS
scale

CITY OF PITTSBURGH
·D·P·W
BUREAU OF ENGINEERING
SEWER EXPLOSION INVESTIGATION
APPARATUS FOR TAKING SAMPLES OF AIR INSIDE OF SEWER.
SEPT 17, 1914

not more than two cars, includes private and small business garages.

Sixty-seven large garages, not less than three cars, includes public garages, repair shops, large business garages, etc.

Twelve gasoline storage establishments.

One dry cleaning establishment.

Two paint shops.

Thirty-nine business or manufacturing places where inflammable oil or gases are manufactured, used, sold, handled or washed; includes gasoline supply establishments, large automobile establishments where gasoline is stored, sold and used in large quantities.

A map was prepared showing the outline of the basin, the sewer system within and the location of all garages, dry cleaning establishments and other places where inflammable or explosive wastes are likely to be discharged into the sewers. The map will be used in connection with studies to locate the point or points where the discharges of inflammable wastes occur.

Letters of inquiry were sent to all the principal cities in the country with a view of obtaining data and information relative to sewer explosions and what laws or ordinances were in force regulating or controlling the discharge of inflammable or explosive wastes into the sewerage systems. The answers received in reply to these inquiries were compiled and have been printed in pamphlet form and copies furnished to each city supplying information.

Apparatus was designed for securing samples of air within the sewer and for making field tests of same. The apparatus used in shown upon the accompanying plan.

The results so far secured in the investigation indicate the presence of gasoline vapor in the sewers of both the 33rd street and Negley Run systems. This latter system drains an area of about 2,500 acres with a population of about 50,000 and there are considerably less sources from which inflammable wastes are discharged than in the 33rd street system. Analysis of a series of samples taken on the same day at various points in these systems have shown that gasoline vapor in small amounts is present thruout the sewer system. The gasoline vapor ranges from 0.012 to 0.065 per cent. of the volume of sewer air in the sample. While these percentages of gasoline vapor are considerably below the danger mark, which may be taken as 2 per cent., it goes to show that the natural ventilation of these sewer systems is not sufficient to remove the effects of the ordinary or normal discharge of gasoline.

The Negley Run system drains thru duplicate outlet sewers for a distance of over a mile, during which distance there are no connections known which could by any possibility discharge gasoline. Above this point, there are a number of large branch sewers of considerable length so that taking these larger sewers of the system together with the many miles of laterals, with the opportunity for ventilation provided, it must follow that natural ventilation would not suffice to remove the effects of the discharge of gasoline in large doses.

It is expected that these experiments will require considerable time before definite conclusions can be reached and preventive measures, based upon same, can be formulated, but it is hoped that some plan or action can be devised which, without imposing hardship or undue expense upon the people, will secure to them freedom from the peril and danger to which they are now constantly exposed.

[The accompanying map shows the Thirty-third street drainage basin and the large number of small garages containing not more than two cars, and the relatively small problem in taking care of larger sources of materials liable to produce explosive mixtures in sewers.

The page of drawings shows the rubber tube let down to the level from which air sample is desired; air pump to draw the gas up; pipette and balloon to receive the gas; also glass tube for receiving samples and apparatus for handling it.]

Re-cut Granite Block Paving in Bronx Boro, New York City.

By George C. Thompson, Engineer of Highways.

Much interest has developed recently in the recutting of worn granite blocks taken from old pavements and relaying them by modern methods. The boro of the Bronx, New York City, was the first municipality to lay such pavements in considerable area, tho perhaps not the first to try the experiment. Mr. Thompson is therefore fitted by experience to describe the beginnings of the process and the improvements that have been made.

THE use of redressed granite blocks, so far as the writer knows, originated in the Boro of The Bronx, and the first piece of work was done under a contract dated September 18, 1909, and it was completed during the succeeding year.

The redressing of granite blocks was suggested to the then chief engineer of the boro by a contractor who was largely interestetd in laying pavement (especially granite blocks), and who also had extensive interests in granite quarries.

The events which led directly to the consideration of redressing old blocks were the letting of several contracts for repaving streets, where the old blocks were to be replaced with some other pavement, and the contractor was required in his bid to include a price per thousand for the taking up and removing of the old blocks from the street. The average price bid for the old blocks and their disposal was very low, it being considered that they were practically without value (the average price being $6 or $7 per thousand), and liable to be held by the contractor indefinitely.

The suggestion was made of trying to redress the blocks to a smaller size and relay with a cement grout filler, to insure the requisite stability. At this time (1909) the specifications for granite pavement on sand required blocks from 8 to 12 inches in length, 7 to 8 inches in depth, and from 3½ to 4½ inches in width, and the average cost for furnishing and laying was $2.86 per square yard, the number laid in a square yard being about 22 blocks.

The proposition to recut these blocks and relay them on a concrete foundation resulted in making specifications for doing the work, following rather closely the same requirement for joints as had been previously used for blocks on a sand foundation. When the letting occurred, the contractor who had made the suggestion proved to be the lowest bidder, at the following prices:

Taking up, redressing and relaying blocks, $1.27 per square yard.

Concrete foundation (1-3-6 mixture), $4 per cubic yard.

The work done under this contract covered an area of over 20,000 square yards of repaving, and included only the space from the railway tracks, existing in the avenue, to the curb on either side. Between the rails and between the tracks was relaid by the railway company with the original blocks on a sand foundation.

The proximity of the two pavements, laid by the different methods, furnished an excellent oportunity for comparison.

As a result of the satisfactory work obtained under the original contract, eight additional contracts have been let and completed for this class of pavement, with modifications from the original requirements, in the proportions of the cement grout filler, the size of the joints and some changes in the method of laying. In the original contract, the grout filler was 1 of cement to 3 of sand, but at the present time it is mixed with equal parts of sand and cement. The joints as at first laid were limited to one inch, and laid to about ¾ inch, while at the present time the maximum joint allowed is ½ inch. To October 1, 1914, there have been laid in the Boro of The Bronx over 212,000 square

yards of the redressed block pavement, which at contract prices has cost over $272,000, or about $1.30 per square yard average for taking up the old blocks, redressing the same and repaving with cement grout filler. The concrete foundation is not included in the cost given, but, as the concrete foundation would have to be provided, the cost of the pavement alone is comparable. The average cost of the redressed block pavement, with a 6-inch concrete foundation, has been about $1.90 per square yard.

At the present time the specification requirements for this kind of pavement are that the block must be from 6 to 12 inches in length, 4¾ to 5¼ inches in depth, and from 3½ to 4½ inches in thickness, and they must be so dressed as to give a smooth surface and lay with joints not exceeding ½ inch. These requirements are practically obtained. The contractor is obliged to maintain the pavement for a period of one year from acceptance as a guarantee of good workmanship. After this time the pavement is maintained by the city.

On contracts recently completed, the average number of blocks laid per square yard was about 38 for ordinary work, running somewhat less per square yard on railroad streets, where long blocks were laid at the rails.

The manner of conducting the work under the contracts is as follows: After the blocks are loosened, the clippers start in, and, with a tracer, score the blocks across the center and break them in two with a blow of a face hammer, leaving a smooth surface on each portion of the broken blocks. The edges are then dressed to the extent necessary to produce the required joint. As a rule, the clippers work independently, but occasionally two men work together, one man tracing the blocks and the other breaking and dressing them. Each clipper throws his blocks into a pile, from which they are culled, then counted and piled on the sidewalk.

The cost of clipping and redressing the blocks varies in accordance with the dressing required. Where the clipping consists of breaking the block in the middle and dressing the edges only, they have been let as low as $10 per thousand, and the tool sharpening done by the contractor.

Where the long blocks for laying against the rails of a street railway are dressed alone, $15 per thousand and sharpening is paid. Where old blocks are redressed to produce modern granite blocks, for first-class work, it costs $25 per thousand.

On a railroad street the blocks are taken up on one side of the roadway at a time, and traffic is maintained. As soon as the blocks are piled on the sidewalk (they are not removed from the street for redressing) the contractor proceeds to turn out the curb, dress to such extent as may be required, then reset same with a concrete foundation and backing, with enough concrete placed in front to form a bond with the roadway foundation, laid later.

The roadway is graded to allow a concrete base 6 inches in thickness, with the top of foundation parallel to the finished crown of the street, and at such a depth below the same as to allow a sand bed not less than 1½ inches in depth, in addition to the paving blocks.

Upon this sand cushion the redressed blocks are laid with close end joints, and joints between courses not exceeding ½ inch in width; longitudinal joints must be broken not less than 3 inches. As the blocks are laid, the joints are filled to within 4 inches of the top with gravel which will pass a ⅜-inch mesh, and be retained by a ⅛-inch mesh.

The blocks are then rammed to an unyielding bed, with a surface conforming to the grade and crown of the street. After the ramming has been done, cement grout, composed of one part of sand and one part of cement, is flushed into the joints. A second ramming is given before the grout sets, and the joints are again filled to the top with a somewhat thicker grout well broomed into the joints, filling them fully to the top of the pavement.

Traffic is kept off the grouted blocks until the grout has had sufficient time to set thoroly, running from 7 to 10 days, according to the conditions of the weather.

In most of the work done a grout surface has been spread over the top of the

blocks and then broomed to a smooth, uniform surface. Unless this is properly done, the surface is liable to wear unevenly and the grout will chip off, leaving the top of the blocks entirely bare, while adjacent blocks will be perfectly covered. This action of the mortar surface has caused considerable annoyance and the cause has not been satisfactorily determined. In some instances it appears to be due to an insufficient ramming, in others to allowing the gravel in the joints to come too near the top of the block before the joint is grouted.

The quality of the granite block appears to affect the adherence of the grout, some of the very hard crystalline blocks not furnishing as good bond as those of finer grain and medium hardness. The writer would be very glad for any information that would explain this action and provide a remedy.

In the work done by Mr. Charles A. Mullen, Commissioner of Public Works in Schenectady, in 1913, many of the old blocks were found to be of sufficient size so that they could be split longitudinally and transversely, thus making four blocks of each one, and making an increase of about 100 per cent in the area that could be laid after redressing. For instance, a block which was 12 by 4 by 8 inches would lay 48 square inches. This would be cut to make four blocks 6 by 4 inches square, or would lay 96 square inches in the smaller block. This block, while shallower than the Bronx block, is reported to have made very good work at a low cost. An article by Mr. Mullen, in MUNICIPAL ENGINEERING for May, 1914, enters into the cost of the work done in Schenectady in great detail, as well as fully describing the methods of doing the work. He assures me that the cost data given in this article are based upon carefully kept returns, and are accurate for the work done. For the convenience of any one who may wish to inspect the Bronx work, I append information as to location, area and contract prices.

Title.	Total Yardage.	Granite Blocks Recut and Relaid, per sq. yd.	Pavement per sq. yd., Including Concrete Foundation.
Webster avenue, from 165th to 171st street	20,227*	$1.27	$1.94
Park avenue E., from 156th to 161st street..	5,241	1.31	1.81
East 151st street..... East 155th street..... East 155th street..... East 160th street..... East 161st street..... Melrose avenue	 32,256	1.38	1.55
179th street, from Park avenue to Third avenue ..	1,815	1.75	2.69
Southern boulevard, from Willis avenue to 138th st.	26,672*	1.05	1.75
Third avenue, from 150th street to 177th street ...	71,369*	1.92½	1.86½
Webster avenue, from 178th street to 177th street.	24,902*	1.22	1.90
Tremont avenue, from Webster ave. to Third ave..	6,371*	1.45	2.18
Tremont avenue, from Third ave. to Boston road.	23,698*	1.53	2.36

*Railroad streets.

In the above mentioned contracts, any excess of blocks belonged to the contractor and any shortage had to be supplied by him at his own expense.

Economics of Sewage Filters.

By George W. Fuller, Consulting Engineer, New York City.

The author of this paper is well fitted by experience to discuss and compare methods of sewage treatment with reference to their relative economic value, and gives much food for thought and careful examination by those trying to find the best method of sewage purification for their particular conditions.

SEWAGE filters may be divided broadly into three classes:

1. Intermittent sand filters or their equivalent. This consists of a body of sand or fairly pervious material of other kinds. The sewage is distributed over the surface of this porous material, and at the bottom the filtered sewage is collected in underdrains. In order to get the benefit of oxidation in the pores of the sand bed, the application of the sewage to the filter is intermittent, with periods of rest and aeration.

2. The second type is the so-called "contact" filter. This consists of a body of practically any thickness of stone or equivalent material, such as large-sized gravel, pieces of porcelain, brickbats, cinders, or almost any coarse-sized granular material. The sewage is applied to such a filter either from the bottom or from the top, so as to fill the bed. The sewage is allowed to stand in this filter bed for a given time. It is then discharged and the empty bed is allowed to stand for a period.

3. The third type is the so-called "sprinkling" filter. This consists of a body of stone of a minimum depth of five feet, on which the sewage is sprinkled or sprayed and spread by nozzles and distributed in small quantities so that the sewage trickles down over the stones and is collected at the bottom.

All three types of filters effect the purification of the sewage in the same way. Thru the action of the bacteria present in the filter bed the sewage is to some extent oxidized and the organic matter is broken up. Unstable forms of matter are changed into more stable forms. While the exact form of action is unknown, it is believed that the three types of filters act in the same way, and the difference is rather a mechanical one of form of application than one of principle of action.

Performance of Filters—The output of a filter of any type, measured in any suitable purification unit, is largely a question of local conditions. It depends upon the nature of the sewage, the nature and fineness or coarseness of the filtering material, the method of application of the sewage to the filtering material, temperature, atmospheric conditions and many other factors. The intermittent sand filter is, best used when it is desired to have a very high degree of purification. The other types, the contact filters and sprinkling filters, are used for a rather lesser degree of purification. It is to be understood that the rate of application of the sewage to the various types of filters must be properly proportioned to the ability of these filters to take care of the sewage. By using a suitable rate under suitable conditions, any type of filter can be made to give any degree of organic purification that may be desired.

Rate of Application of Settled Sewage to Filters—The question of the rate of application of sewage to a sand filter is largely tied up with the question of preliminary treatment in the way of tankage or screens. Quoting from my book, "Sewage Disposal," we make the following table for several cities in Massachusetts of the population whose sewage can be treated per acre of filter bed, with the time of detention in preliminary sedimentation tanks, storage wells, pump wells, or other means of storage. These figures are not to be taken to represent present conditions.

	Period of Detention, Hours.	Population.
Andover	1½-3	950
Brockton	12	1,160

Clinton	12	425
Framingham	12	375
Gardner (Old)	1½	1,310
Gardner (New)	1½	2,000
Pittsfield	12	605
Stockbridge	8	220
Worcester	1½	1,390
Average of all	6.7	937

The Baltimore Sewerage Commission in 1906 estimated that, using a sand filter with 3 feet of clean sand over the gravel, an allowance of 150,000 gallons of 6-hour settled sewage per acre in 24 hours, corresponding approximately to 1,200 people per acre, would be a proper rate.

Data for contact filters are relatively scant in American practice, and, while many English data are available, the differences, owing to the difference in the strength of the sewage, make such data rather dangerous as a basis of comparison.

A series of experiments in Columbus, Ohio, indicated that 5-foot-deep stone filters on the contact principle could be safely operated at an average of 600,000 to 700,000 gallons per acre per day. Reducing this to a 4-foot depth will give about 500,000 gallons per acre per day, which, on the basis of 100,000 gallons per capita per day, would give a loading of approximately 5,000 people per acre of stone bed.

A series of tests made at Lawrence on contact beds of various depths from 24 inches up to 18 feet showed an average output of some 700,000 gallons per acre per day for a depth of stone on an average about 5½ feet. This is equivalent to an output of about 135,000 gallons per acre for each foot of depth of stone, or, for a 4-foot depth of bed again, is equal to about 500,000 gallons per acre per day, or, say, a loading of about 5,000 people to the acre.

The contact filter installation at Plainfield, N. J., with 3.6 acres of stone bed 4½ feet deep, gave in 1910 an output on an average of 1.7 million gallons of sewage per day. On the basis of an allowance of 100 gallons per capita per day, this will correspond with a 4-foot bed, to about 4,200 people per acre of filter.

For sprinkling filters much more satisfactory data can be had. Sprinkling filters have been used very extensively in this country of recent years and their ratings can be fixed with a good deal more dependence. A list of a number of plants or projected plants, giving the depths of the stone bed of a sprinkling filter and the loading in population per acre follows:

	Depth, Feet.	Population Per Acre.
Atlanta	6	20,000
Reading	5	18,000
Columbus	5	18,000
Baltimore	9	20,000
Montclair	7½	15,000
Philadelphia	6	20,000
Fitchburg	10	20,000
Mount Vernon	8	24,000

The average of all these shows a 7-foot deep bed and average loading of 19,400 population to the acre.

Not considering special conditions, and just taking fair figures, we may safely state the following:

Intermittent sand filters, 3-foot bed of sand, loading 1,000 population per acre.

Contact filters, 4-foot depth of stone, loading 5,000 population per acre.

Sprinkling filters, 7-foot depth of stone, loading population 19,000 population per acre.

The rates, then, for these three types of filters are in the ratio 1, 5 and 19 feet.

Cost of Sewage Filters—Costs of construction are so much affected by local conditions, such as the amount of excavation necessary, the cost of various classes of materials, the distance from which various classes of material must be obtained, details of local construction conditions, such as competition, class of work required, and others, that comparative costs for different localities are only to be used with great discretion, and individual cost and even averages are only a guide to comparative costs in various places. Having this limitation in mind, we will examine in a rough way the cost of various types of sewage filters on the per capita basis.

The average cost of the nine Massachusetts intermittent sand filters cited above is $3,260 per acre, as reported in the Massachusetts State Board of Health report of 1903. This gives a cost per capita connected to the filters of $3.50.

The 1906 Baltimore Sewerage Commission estimates the cost per acre of filters at $6,350, these filters being suitable

for a connected population of 1,200 per acre. This corresponds to a per capita cost of $5.30.

The cost of contact filters, varying, of course, with the degree of the fineness of the design, may be taken, for filters equipped with suitable convenient appurtenances, at $30,000.00 per acre for a 4-foot deep bed. This corresponds with a loading of 5,000 population per acre to a per capita cost of $6.

For sprinkling filters 7 feet deep the cost will be about $45,000 per acre. On the basis of a loading of 19,000 population per acre, the cost per capita will be $2.37.

When considering the relatively low cost of the Massachusetts sand filters compared with the estimate made from the Baltimore sand filters, it is to be borne in mind that the conditions in Massachusetts for the construction of sand filters were unusually favorable, and do not represent average conditions thru the country. In most places the costs would approximate more nearly those estimated for Baltimore.

Taken in a broad way, sprinkling filters are a far more economical installation in the matter of first cost. Intermittent sand filters and contact filters do not stand far apart in this particular.

Relative Cost of Different Depths—There is not very much known about the relative advantages of filters of shallow or deep construction. The choice of depth is usually made for entirely different reasons from those of obtaining the most economical construction to obtain the desired amount of purification. Very few tests of a comparative kind have been made to give convincing information, and the interpretation of the tests has not been uniform. In some places the conclusion has been made to make filters say 10 feet, at other places 6 feet, and some study is worth while to determine what, if any, difference there be in the cost of such construction at different depths, and which appear to be the better. It is to be assumed in such comparisons that sufficient head would be available in any case for the greatest depth to be considered and that pumping would not be necessitated by building filters of the greater depth.

For intermittent sand filters questions of depth do not arise. The filters are generally made as shallow as is consistent with getting proper results, and sand beds are not usually made more than 4 or 5 feet deep as a maximum. Shallower beds, even, will give about the same output as the deeper beds, and beds are made deep only so that sand may be removed for cleaning without removing the sand for a considerable period.

With contact filters it is recognized that from the nature of the action of the contact filters, where the amount of air that is drawn in between fillings of sewage is practically equal to the volume of the sewage, and where surface clogging cannot be a serious factor and may even be no factor at all, each unit of volume of the stone forming the filter, say each cubic yard, will give the same output of sewage purification, no matter what may be the depth of the filter.

From this it follows that it is economical to build a sewage filter on the contact principle as deep as local conditions of construction will permit, and the limitation of depth which it is economical to use is therefore made by the factors of earth excavation or fill and the possible head available without pumping.

When it comes to sprinkling filters, the problem becomes a little more complicated. The English experience, as recited in the report to the royal commission, seems to indicate that the output per unit of volume of sprinkling filters is the same, no matter what the depth. Our experience in work in this country does not wholly corroborate this information. Our best knowledge seems to indicate that the output per unit of volume of sprinkling filters is somewhat less for deep filters than for shallow filters. For such conditions, with a relatively decreasing efficiency of the stone of the filter beds for greater depths and at the same time a relatively decreasing cost per unit volume of the stone for deep beds, there must come some point where the greatest output per unit of cost will be obtained.

The report of the Baltimore Sewerage Commission in 1911 gives some informa-

tion obtained from tests made in Baltimore as to the relative efficiency of various depths of broken stone of sizes 1 to 2-inch stone, which is the one most commonly used. Figures obtained from that source show that the following:

	6 ft.	9 ft.	12 ft.
Relative stability.....	79	87	89
Per cent. reduction of oxygen consumed	56	70	72

Giving equal weight to the relative stability and per cent. reduction of oxygen consumed, we get the following:

	6 ft.	9 ft.	12 ft.
Relative stability	1	1.2	1.23
Per cent. reduction of oxygen consumed.....	1	1.25	1.28
Average of the two...	1	1.22	1.25
Relative depths.....	1	1.33	2.00
Relative value of stone per cubic yard.....	1	.92	.63

Assuming this depth varies at a uniform rate from one end of the curve to the other, we get the following for the relative value of stone per cubic yard:

Relative Depth of bed, feet	6	7	8	9	10	12
Relative value of stone per cubic yard..	1.0	0.97	0.94	0.92	0.82	0.63

To get comparative figures then between the 6, 8 and 10-foot beds the cost figures for the 8-foot beds must be divided by 0.94, and the cost for the 10-foot beds by 0.82, putting them all on the basis of the 6-foot beds.

For comparative cost a number of factors, such as excavation, etc., are naturally omitted, as they are not affected in all places the same way by the depth of the filter. Comparing, then, only those particular costs which are affected per unit of output by the depth of the filter, we get the following:

	Per effective cu. yd. Depths.		
	6 ft.	7 ft.	8 ft.
Floor—Take at 0.40 per cubic yard for a 6-foot bed. Floor..	$0.40	$0.35	$0.32
Tile—Take 11c per square foot for any depth	.49	.44	.40
Walls—Assume cost 0.17 per cubic yard for 6-foot depth.....	.17	.17	.17
Galleries and Collectors—Assume for 6-foot depth 0.25 per cubic yard	.25	.22	.20
Distribution—Assume 0.50 per cubic yard for 6-foot depth also, as costs theoretically vary only according to quantity delivered, they must be same for all effective depths per cubic yard.....	.50	.50	.50
Stone—Assume $1.50 per cubic yard.....	1.50	1.55	1.60
Total	$3.31	$3.23	$3.20

Outside factors will depend on quantity only and not on depth.

It appears, then, that there is some slight saving of cost, which, on the figures given in the table, amount to about 3 per cent. in favor of the 8-foot bed as compared with the 6-foot bed. On the other hand, it is to be recognized that a deep bed will give a good deal more trouble with pooling and freezing than a shallow bed, and the advantages in favor of a shallow bed due to this lesser amount of pooling will be considerably more than this 3 per cent. difference in cost. Taking everything into account, the writer believes that a sprinkling filter bed of not less than 6 feet and not more than 7 feet will in the greater number of cases prove the most economical to use.

Gas Leaks Under Bituminous Pavements.

By George C. Warren, Boston, Mass.

There has been some difference of opinion as to the effect of illuminating gas upon bituminous pavements, due to lack of information on the subject and to the differences in effect upon various asphalts. These experiments by Mr. Warren show the facts in one series of cases, and the accompanying discussion by S. R. Church extends the application to other cases, and they demonstrate the serious nature of the effects of leaking illuminating gas upon the bituminous pavement which it may pass thru.

TO everyone who has had long experience in bituminous pavement construction and maintenance, it is well known that illuminating gas escaping from subsurface gas mains is very injurious to all forms of bituminous pavements, and yet we frequently find representatives of gas companies and city officials ridiculing the idea that gas can have any effect on such pavement surfaces.

The fact is that illuminating gas, a bituminous substance, and hydro-carbon, quite similar in its chemical composition to light tar and oil distillates, is lighter and more penetrating than the distillates and even more rapidly attacks and liquefies a bituminous cement, no matter whether the bitumen be a tar or an asphaltic product.

EXPERIMENT NO. 1.

For testing the effect of illuminating gas on asphalt there is submitted herewith a very simple apparatus and photograph thereof.

Photo taken at start of experiment, August 18, 1914.

Illuminating gas entered at tube "C," filled the jar and passed out at tube "D" to a burner.

Gas passed thru jar daily 8 a. m. to 5 p. m., from August 18, 1914, to October 5, 1914, except Sundays and Labor Day, but naturally the jar was filled with quiet gas during nights, Sundays and Labor Day.

The glass jar contains two baskets of No. 10 mesh screen.

Basket A contains 1-inch cube of hard California refined asphalt penetration 20 degrees Dow.

Basket B contains 1-inch cube of mixture consisting of 90 per cent. well graded sand and 10 per cent California asphaltic cement (75 degrees Dow.).

A similar jar and contents, which was not subjected to gas, has been kept alongside of the "gas jar" during the experiment to show that softening of material in the gas jar was due to gas and not change of temperature, and is exhibited herewith. (See Photo 6.).

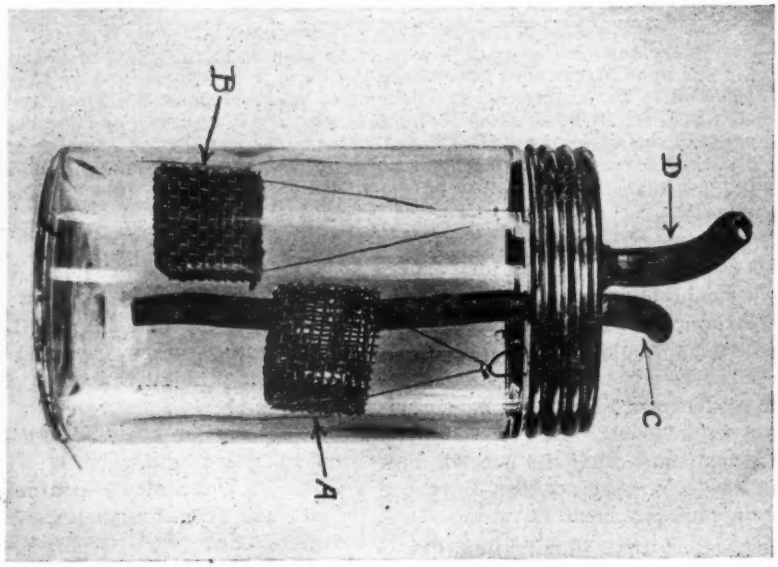
Photos 2 to 5 inclusive are of the same jar as shown in Photo 1, taken during the test of six weeks on the following dates, respectively: September 3, 12, 16 and 24.

Photo 6 shows that the softening was in no way due to change of temperature.

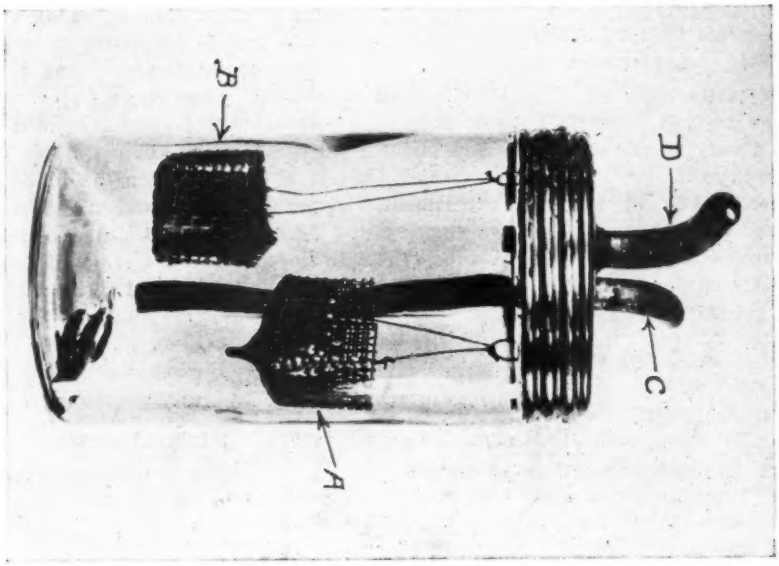
The daily diary of condition of asphalt and mixture is as follows:

EXPERIMENT STARTED AUGUST 18, 1914.

Asphalt Basket.	Mixture Basket.
Aug. 19 to 27—No noticeable change.	No change except mixture glossy and sticky.
Aug. 28—Asphalt began to creep thru, looking like small beads in the wire mesh.	Ditto above.
Aug. 29—Ditto above.	Ditto above.
Aug. 30—Gas turned off; Sunday; no observation.	Ditto above.



GLASS JAR CONTAINING BASKETS *of hard asphalt and sand asphalt mixture. Photo 1.*



GAS JAR SEPT. 3, 1914, *after fifteen days' exposure to gas. Photo 2.*

Aug. 31—Outside of wire basket coated with asphalt which had crept thru the mesh.	Ditto above.
Sept. 1—Above condition slightly increased.	Ditto above.
Sept. 2—Asphalt forming drop at bottom of basket.	Ditto above.
Sept. 3—Asphalt increasing in softness; above drop has formed long pendant and small portion dropped to bottom of jar. See Photo 4.	Ditto above.
Sept. 4—Ditto above; more drops.	Ditto above.
Sept. 5—Ditto above; more drops.	
Sept. 6—Sunday; gas turned off; no observation.	Sunday.
Sept. 7—Holiday; gas turned off; no observation.	Holiday.
Sept. 8—Three distinct pendant drops of asphalt surface settled half way down basket.	Same as Sept. 5.
Sept. 9—Same as above.	Same as Sept. 5.
Sept. 10—Same as above.	Same as Sept. 5.
Sept. 11 to 28—Impossible to make intelligible diary, there being almost imperceptible changes from day to day. There has been, however, continuous but slow leakage of asphalt from the basket. The long pendant drop shown in Photo 2 broke on September 12. A new drop started to form at that time and on September 28 had reached about three-quarters the distance from basket to bottom of jar.	

RESULTS OF EXPERIMENT NO. 1.

	Mixture Basket	Refined Asp. Basket
Net weight of material at start	17.90 grams	14.13 grams
Net weight of material Sept. 28 (41 days)	18.04 grams	10.52 grams
Increase in weight	.14 grams	.....
Equals 0.78 per cent. of the mixture, or 8 per cent. of the bitumen.		
Amount of asphalt dripped from basket		3.61 grams
Amount of asphalt dripped from basket		23.50 per ct.

The paving mixture of asphalt and sand has become reduced to the condition of a mixture of heavy oil and sand.

The foregoing experiment clearly proves the following fundamental facts:

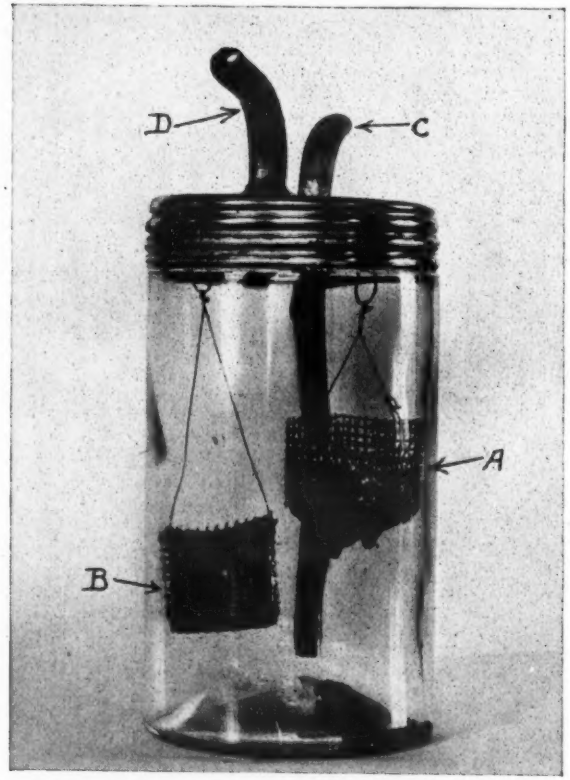
(a) That illuminating gas without agitation rapidly liquefies asphalt cement and refined asphalt and destroys its value as a cementing medium.

(b) That illuminating gas not only attacks, but combines with the asphalt, increasing its weight.

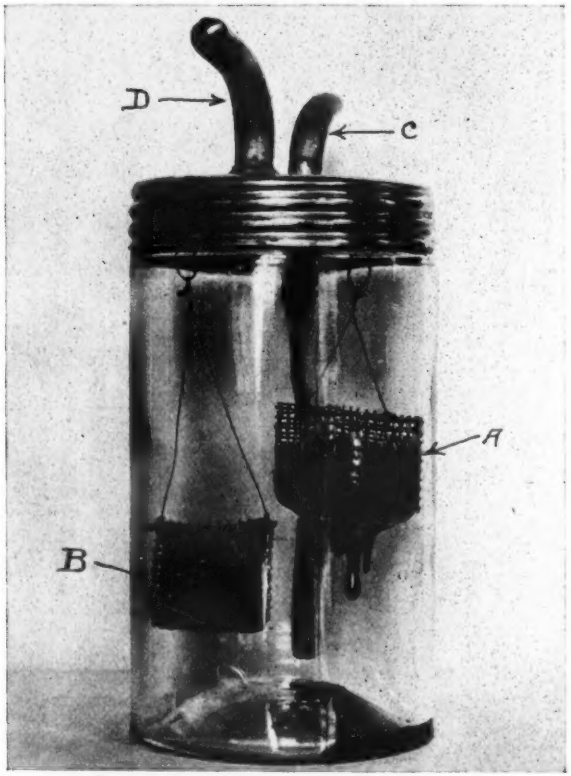
EXPERIMENT NO. 2.

Commercial illuminating gas is very complex in composition, and the portion which produces the luminous portion of the normal flame is very similar in composition to benzol, which, when chemically pure, is practically a perfect solvent for the bitumen which is the active component of all asphalts and coal tar pitches.

It is but natural, then, that when this gas comes in contact with any bituminous cement, more or less of the "illuminants"



GAS JAR SEPT. 12, 1914, *after twenty-four days' exposure to gas. Photo* 3.



GAS JAR SEPT. 16, 1914, *after twenty-eight days' exposure to gas. Photo* 4.

of the gas are absorbed by the bituminous cement, and the candle power of the gas is correspondingly reduced, and it is on account of this fact that the gas companies not only exercise the greatest possible care in cooling the gas to condense and separate out as completely as possible all oils and tars, but also for many years have insisted that all the cast iron pipes used as mains be coated with "asphalt dip" on the outside only, even tho such pipe is more expensive.

In the ordinary process for the manufacture of coal gas the candle power is usually less than desired and the gas is usually enriched by the addition of water gas, the latter being produced by the chemical combination of petroleum oil and steam under application of high heat.

It may not be generally known to those present, however, that in the absence of a carbureted water gas plant the most available method of enriching the gas is the direct addition of benzol vapor to not over 3 per cent.

In order to show the rapidity with which asphalt cement will absorb illuminants from gas, Experiment 2 is submitted herewith:

The apparatus is designed to show the comparative brilliancy of two flames of identical size, one burning normal gas which has passed thru a glass tube containing dry sand, the other flame burning gas which has passed thru a corresponding ¾-inch tube, 32 inches long, containing a sand-asphalt mixture. It will be noted that in the case of the normal flame the "blue" portion is very small and the flame luminous, while in the other the "blue" portion of the flame is relatively much larger and the flame itself much lower candle power.

While this comparison can be plainly seen, as shown in Photo 7, the contrast is more marked when the oiled paper screen is placed in front of the burners, as shown in Photo 8.

From the point of view opposite to Experiment 1, Experiment 2 proves the injurious effect on illuminating gas by contact with asphalt or other viscous bituminous material.

EXPERIMENT 3.

Having proved the effect on the bituminous cement and on the illuminating gas by their contact with each other, the next step in our experiments is to measure that effect on the bituminous material as a softening agent.

This experiment was made by filling a one-quart fruit jar about 6 inches deep with liquid asphalt of specific gravity of 1.0 on afternoon of September 18. It is necessary in carrying out this test to employ liquid asphalt, and also to apply the gas under higher pressure than is on the ordinary gas burner, in order that the gas may pass freely thru the asphalt.

Two tubes were inserted, one for inlet of gas extending to bottom of jar, the outlet tube being, of course, above the surface of the asphalt, with a burner at top of tube. With the exception of Sundays, September 20 and 27, gas has been passing thru this asphalt and burned at outlet.

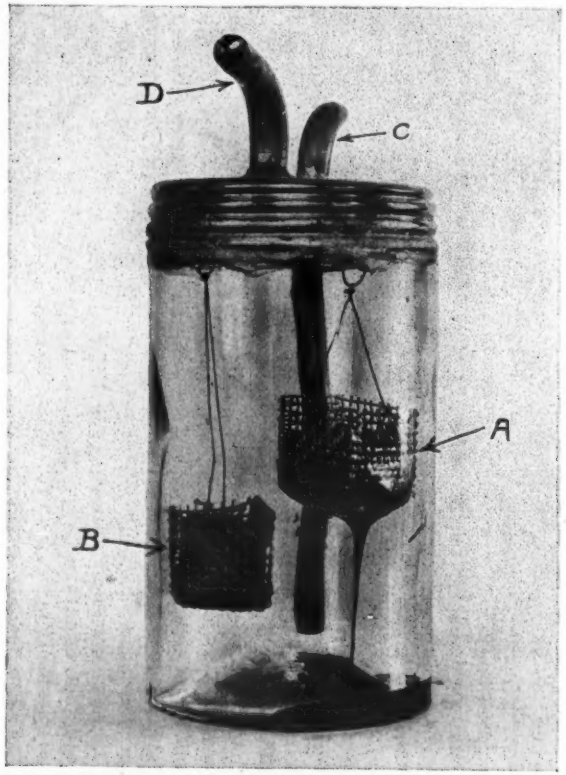
After twelve days' exposure to gas the asphalt had increased 2.98 per cent. by weight and 4 per cent. in volume.

The comparative characteristics of this liquid asphalt before and after the above exposure to gas are as follows:

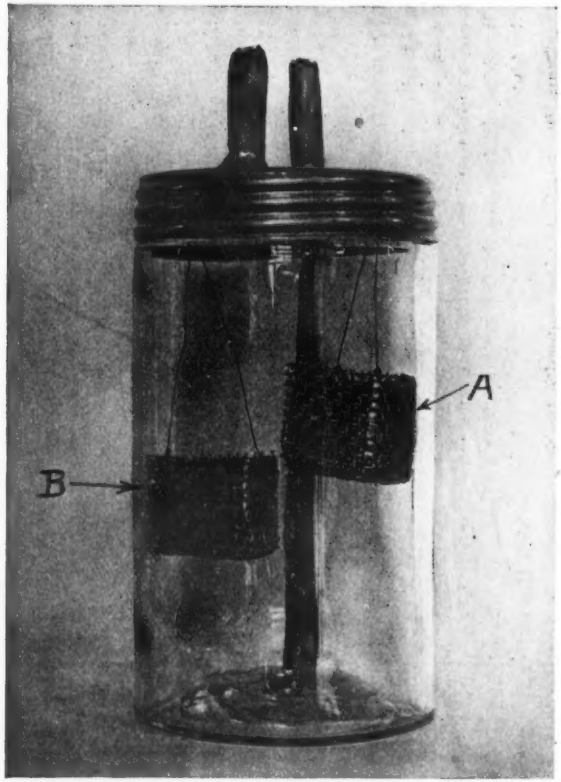
	Before.	After.
Specific gravity at 60 deg. F..	1.00	0.99
Flash point, deg. F.....	190	120
Engler viscosity—		
1st 50 c. c., sec.....	153	75
2nd 50 c. c., sec.....	170	90
Weight, grams 953.1		983.6
Increase of weight, per cent..		2.96
Volume, c. c. 955.1		993.5
Increase in volume, per cent..		4

It may be well to here state that while asphalt and sand mixtures are used in making these tests, being more convenient for small experiments than coarser bituminous mixtures, it is not intended to claim that one bituminous paving mixture is more readily affected by gas exposure than another, and more particularly it is not claimed that the particular form of bituminous pavement surface in which the writer is most commercially interested is affected to any less degree than other bituminous mixtures.

The foregoing is of practical as well as scientific interest and believed to be worthy of record in the proceedings of



GAS JAR SEPT 24, 1914, *after thirty-six days' exposure to gas. Photo* 5.



JAR CONTAINING *baskets of hard asphalt and sand asphalt mixture same as in the jar shown in preceding photos. This jar was not subjected to gas, but stood alongside of the other jar during entire experiment. Photo taken October* 5, 1914. *Photo* 6.

this society. To us, as practical road engineers and road builders, however, the important questions are the title of this paper, "The Effect of Leaking Illuminating Gas on Bituminous Pavements," and "What are we going to do about it?"

In my thirty years of experience with asphalt and other bituminous pavement construction, this matter has come up many times, and generally the persistent claim of the gas companies is:

1. That it is ridiculous to suppose that gas will attack an asphalt pavement.
2. That the gas mains have been carefully tested by plugging holes thru the pavement and into the ground and that there are no leaks.
3. When the main is on the side of the street opposite a portion of the street affected, it is too far away.

I would comment on these points as follows:

1. There can be no question but that coal gas, being a hydro-carbon in gaseous, and therefore its most penetrating, form, will attack any form of bitumen even more rapidly than oil, just as gasoline, being more penetrating, will attack bitumen more rapidly than heavier oil, such as machine oil, for instance.

I particularly remember one extremely aggravated case on West End avenue, New York City, about fifteen years ago, which became reaffected, and the asphalt pavement again ruined within three months after it was resurfaced, the gas company having claimed that they had thoroly tested the mains and repaired the leaks. Shortly subsequent to this the gas company was obliged to entirely relay the gas main and the pavement was again relaid.

2. Even if they dislike to, or will not admit it, the gas companies well know that the "plugging" test only *sometimes* locates the leaks. They naturally dislike to go to the expense of tearing up and relaying pavements and excavating to and uncovering the mains, unless the conditions become such that they are absolutely required to do so.

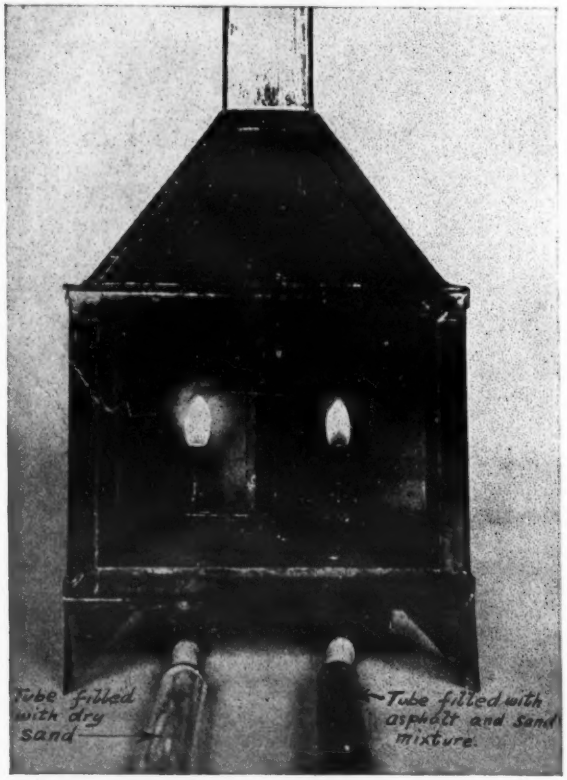
3. The leaking gas naturally follows the lines of least resistance, which may be in either a nearly vertical line and show the result almost immediately above the leak, or what is extremely hard to find, may follow a long distance thru a vein of porous earth or along the space formed by some old settled trench and reach the pavement surface a long distance from the leak. In such cases the pavement is generally affected over a large area, because the earth has become quite generally saturated with the gas, which gradually works up to the pavement surface.

I remember a case in about 1888 on Rutger street, Utica, N. Y., where the first indication of trouble in the gas main was the effect on the asphalt pavement. The gas company claimed they had repaired the leak and a considerable area of pavement was relaid. About a month later an elderly couple, while asleep in one of the residences nearly a block away, were nearly asphyxiated by gas leaking from the street. Probably the gas had first found a partial outlet, following along a vacancy in some trench settlement, and then thru the pavement. Subsequently the leak became worse, with the serious result referred to above.

Frequently, if not generally, the first indication of leak in the gas main where the street is a bituminous pavement, is the effect on the pavement, in which case it is good fortune that the pavement is of a character which is affected by gas and will permit the gas to permeate the surface, thus lessening the chance of serious casualty as above outlined in Utica.

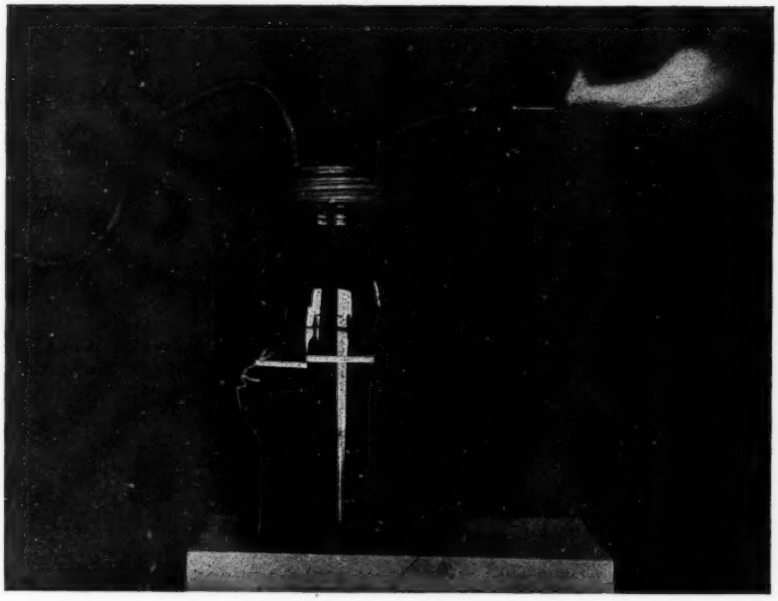
The visible effect of leaking gas on a bituminous pavement is a serious "shifting" or "rolling" of the pavement in its softened condition, accompanied by a breaking up of the surface into a "crackled" appearance not unlike the folds or cracks in an alligator's back.

Generally when this condition is noticed, a perceptible odor of gas will be found in the pavement surface, but sometimes the leak may have been repaired or the gas taken another course and the gas escaped so that its odor cannot be detected, yet the pavement is left in a seriously damaged condition. On the other hand, under certain sub-soil conditions, the earth below the pavement may retain the escaped gas and continue to have its damaging effect for months, if not years, after the gas main has been repaired, and the cause of the trouble probably removed.



FRONT SIDE *of apparatus entirely open, showing the burners and character of flames. On left showing brilliant flame of normal illuminating gas. On right showing darkened flame from gas which has passed thru sand-asphalt mixture. Note the difference in the size of the "blue" portions of each flame and difference in brilliancy of the "halo" around each. Photo 7.*

FRONT SIDE *of apparatus closed by a translucent oiled paper screen, showing at left side bright light from normal flame and at right darkened light from gas which has passed thru sand-asphalt mixture. Photo 8.*



GLASS JAR *containing liquid California asphalt. Gas entering at A and out at B. Photo* 9.

The effect on the pavement may extend for a considerable period beyond the repairs to the gas main, unless steps are taken to provide frequent vents left open for several days if not weeks after repairs to the gas mains are made.

In such cases, before making repairs to the pavement, its entire surface over the main and where the surface shows the effect of gas, should be removed and the gas main should be thoroly repaired (renewed if necessary). After the leaks are repaired, vents or openings at least 1 foot square, extending from the surface to the level of the gas main, should be left open for two or three weeks longer, if there is still any odor of gas, and the openings then refilled and thoroly tamped and the pavement surface relaid. With this precaution the trouble will probably be overcome if the gas company has not been too parsimonious, inefficient or incomplete in making of repairs to the gas mains.

In conclusion, it may be well to call attention to a pernicious but quite general custom of the gas companies in their "hunt" for leaks. I refer to the custom of having two or three men, one of them selected for his "smelling" efficiency, go along the street, where there are indications of gas leaks, hammering a cone-shaped bar thru the pavement into the ground below. These holes are made at intervals of a few feet. The "smeller" man puts his nose to the holes and if he discovers a sufficient odor of gas to attract his attention, an opening is dug to try to discover the leak. If the "smell" test does not locate a leak apparently below the hole, it is quietly filled with dirt. A few weeks later the city official, or the "poor devil" of a paving contractor, if he happens to have the pavement under "guaranty," finds serious holes along the center line of the pavement and not being able to trace the trouble to any cause, he makes the repair, if his "guaranty" is good, or "lets it slide" if he and his "guaranty" are no good, and perhaps at the end of a law suit the city makes the repairs. The simple, but so far as the writer knows never enacted, cure for this evil is an ordinance requiring gas companies, whenever they want to test their mains, to cut openings of sufficient size thru the pavement to enable excavation to the gas main, abso-

lutely prohibiting the promiscuous drilling of holes thru the pavement as above described and to pay for making a proper repair to the pavement. With the enactment and enforcement of such ordinance the chances of locating the leaks are greatly increased and the unfairness to the city and contractor of making holes in the pavement without adequately repairing them will be eliminated.

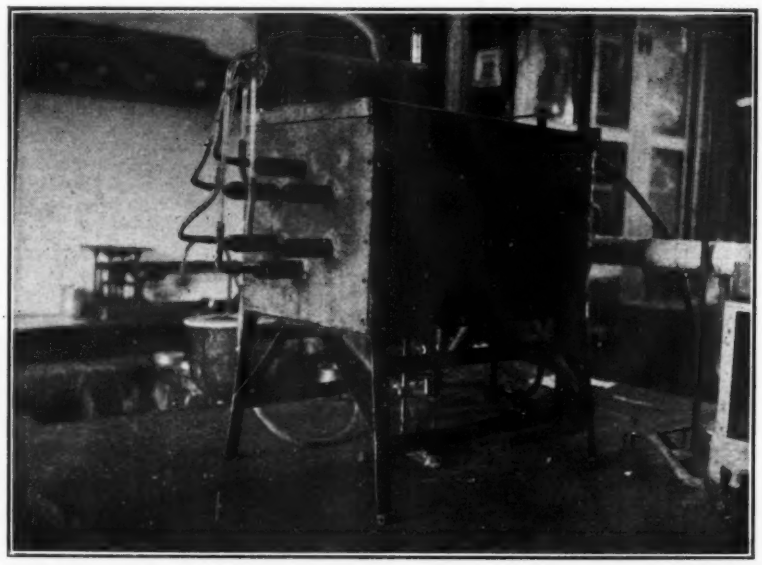
DISCUSSION

By S. R. Church, New York City.

THE destructive effect upon bitumens of illuminating gas, and also of the liquid that condenses from illuminating gas in the holders and mains, was first called to my attention during 1907, in connection with an investigation of the comparative value of various bitumens for waterproofing underground structures. At that time I conducted a number of laboratory tests along lines very similar to those described by Mr. Warren, and found, as he had found, that in an atmosphere of illuminating gas bitumens are softened very appreciably. I also found that the solvent action of the gas condensate, commonly known as "gas drips," on the bitumen, was very marked.

More recently, we have undertaken an investigation of the physical and chemical characteristics of a wide range of bitumens, including asphalts and tar pitches. That portion of the investigation dealing with the effect of illuminating gas on bitumens was conducted as follows:

Accurately weighed quantities of the bituminous material were placed in ordinary porcelain combustion boats and were exposed to the effect of a stream of illuminating gas flowing at a rate of 3.5 cubic feet per hour for six days. The tests were carried out in specially constructed iron tubes in which a temperature of 15 degrees C. was maintained by means of a water jacket, and a burner controlled by a metallic regulator. The flow of illuminating gas was regulated by meter control.



VIEW OF APPARATUS *used to expose asphalt samples to stream of illuminating gas in the tubes shown projecting from the end of the water jacket heated by gas burners below.*

and by having the gas pass thru a definite opening of 1/64-inch diameter. At the end of the test the boats were removed, weighed, and the bitumen removed from the boats, run into small metal containers, and penetration at 77 degrees F. determined for comparison with the original penetration test of the bitumen.

The bitumens tested all showed increases in weight, varying from 0.1 per cent. to 4 per cent. As Mr. Warren has only given the results of his tests on one particular type of bitumen, I will not enter into a discussion of the comparative results at this time, except to say that bitumens vary greatly in their susceptibility to illuminating gas. However, as stated by Mr. Warren, they are all affected by it, and almost all of them show measurable increases in penetration. In some cases this increase in penetration was as much as 60 degrees Dow.

The solvent action of gas drip on bitumens was determined by carefully preparing films of uniform thickness, and measuring the time required for gas drip under a definite head to penetrate thru the films. I will not discuss the details of this test at present, except to say that here also the bitumens were all affected, but some failed much more rapidly than others.

We expect to publish the results of our investigations before very long, and hope that a consideration of the results will lead others to undertake a study of the comparative resistance of different bitumens to the effect of gas. As Mr. Warren has pointed out, this is a very important matter, and sufficient attention has not been given to it.

Cleaning Bituminous Streets Without Sprinkling.

By Walter F. Slade, Commissioner of Public Works, Providence, R. I.

This note regarding the method of street cleaning in use in Providence, R. I., and the accompanying discussion by Mr. Warren, discuss a very important subject and one on which there has been much difference of opinion. The success of the method here described depends largely on the paving conditions and the care with which the process is applied, as set out by Mr. Warren.

THE fact that bituminous pavements laid in the city of Providence are not sprinkled with water is a subject that has occasioned frequent comments on the part of visitors to this city who are interested in the maintenance and cleaning of such pavements.

I will say briefly that we are convinced that bituminous pavement maintained in good repair can be kept in a condition more satisfactory to all classes that travel the streets, both afoot and in vehicles, without, rather than with, using water for sprinkling.

We keep them clean by the patrol system, and reasonably free from dust. We believe that the use of water has an injurious effect upon the durability of the pavement. It emphasizes every slight depression and gathers and retains the fine particles that collect on a street, creating an unsightly appearance and a muddy, slippery condition. This results in the skidding of automobiles and a vast increase in the number of accidents.

By keeping the pavements free from water we escape another prolific source of complaint. Upon the best of pavements there will be depressions sufficient to retain a thin sheet of water. The rubber tires of the swiftly moving auto, and especially the auto truck, will act as a syringe and force the muddy water in a small stream upon the clothing of any one passing along the sidewalk, and even across the sidewalk, covering windows and buildings with muddy spots.

That more might be learned upon the

action of water as affecting the durability of bituminous pavements, it would be instructive to bring out the results of laboratory tests, and a comparison of the condition of streets laid about the same time, where water was used and where not. The whole question is a subject worthy of the earnest consideration of all officers that have charge of the maintenance of bituminous pavements.

DISCUSSION

By George C. Warren, Boston, Mass.

COMMISSIONER SLADE has presented one of the shortest and what, to my mind, is one of the most important, comprehensive and useful papers which this convention has received in many years.

From seven years practical trial the city of Providence has practically proved what I believe to be a fact, that street sprinkling, as it is quite generally practiced, is worse than a useless expense. In fact, I believe it to be a relic handed down from past generations and conditions. Providence, a city having a population of nearly if not fully 200,000, has all kinds of street pavements, and scarcely any city in the country has them in as uniformly good, cleanly condition. Commissioner Slade tells us that this has been accomplished absolutely without sprinkling for seven years on all kinds of pavement, except that water-bound macadam is occasionally sprinkled with oil or oil emulsion. That is an object lesson which other municipalities will do well to emulate.

Fifteen years ago, when most of our street surfaces were macadam and dirt and the comparatively few modern pavement surfaces were intercepted by macadam and dirt roads, and traffic entirely horse-drawn, the sprinkling of pavements to keep down the dirt was essential. Since then there has been a rapid evolution until now much the greater percentage of traffic is motor-driven and rubber tires, which make no dirt. The great majority of the pavement surfaces of our city streets now consist of some form of modern, nearly waterproof pavement. And still we follow the old antiquated custom of keeping the little dirt wet down with street sprinklers, providing a muddy, nasty surface which cannot be thoroughly cleaned and necessitates more sprinkling and more mud until the gutters become receptacles of mud, and, if the pavement surface ever gets dry, the hue and cry go up, "Where is the sprinkling cart?"

We not only have the benefit of the seven years' experience of Providence, but we have our own country roads for an object lesson. Last week I took a 250-mile automobile ride over the bituminous surfaced country roads of Massachusetts, which have never been sprinkled, and most of them never cleaned. There had been no rain for at least three weeks and I did not find a dirty road on the entire trip. A week before I had a similar experience over 100 miles of bituminous road surface in Connecticut. This, notwithstanding that the country road surface is generally only 16 feet wide, with a similar width of dirt "shoulders' on either side, while our city streets are paved with a naturally clean surface from curb to curb. Why is this? It is simply because, without wetting down the dirt as fast as it forms and thus causing it to accumulate, as soon as an imperceptible dirt particle forms on the road surface it is picked up by the natural wind and rapidly moving automobile and thrown aside and in such small quantities that it is imperceptible and unnoticed and therefore does no harm.

Another important point is that if bituminous pavement surfaces are dry and clean the oil which drops from automobiles is quickly spread by auto tires to an extremely thin sheet which not only preserves the pavement but the slight amount of oil takes up the fine dust and materially helps to prevent the pavement surface

from ever becoming dusty. If the pavement surface is wet these valuable effects of the slight dropping of oil from automobiles is entirely lost.

Of course, in the case of city streets it is necessary, as Providence has done, to inaugurate a daily patrol system of street cleaning to pick up the horse droppings before they can become converted into dust, and to work around the intersections of unpaved streets, if any. Some one or more of the systems of pneumatic cleaning machines, now in the process of development, will surely soon be a practical success, but until then street washing at night is necessary under some conditions, but not generally so. I believe that such a system of dry cleaning by hand patrol is less costly than the antiquated street sprinkling, supplemented by the street sweeper trying to do the impossible—thoroly pick up the accumulation of mud. Even if dry cleaning were not cheaper, its greater efficiency in keeping street surfaces in better condition for use by automobiles, horses and foot passengers, merits its adoption, to say nothing of the far greater durability of all forms of street pavement surfaces when dry than when wet. It is generally conceded that water is the worst enemy of all pavement surfaces. When the water is applied in the form of wetting down an accumulation of dirt subjected to steel-tired traffic, we have the condition which from all ages has been known to wear the hardest steel and is therefore used in the grindstone and for sawing stone—to wit, the application of mud under a grinding process.

While some forms of pavement are doubtless more affected by water and mud than others, it injuriously affects all classes of pavement, and I will not except stone, even granite blocks, the wearing of which to a "turtle back" surface I believe to be primarily due to slight absorption of water.

I believe that repairs required to all classes of pavement are more generally the result of wetting down the dirt, leaving the surface in a continually more or less muddy condition, than by the traffic, or rather what would be the traffic under dry, cleanly conditions. A city or street in or on which sprinkling or other method of continual wetting of the pavement surface has not been practiced is almost universally one where the pavements are the best of their kind, no matter what form of pavement construction is used.

Washington, D. C., has the enviable reputation of having the most durable pavements of all kinds. For many years the system of cleaning in Washington has been hand patrol without sprinkling, except a very light sprinkling—just enough to lay the dust but never to convert it into mud—immediately in advance of the night sweeping.

Fifth avenue, New York, is always dry, except during rains, and we find one of the most durable asphalt pavements in the world. Fifth avenue provides an excellent single example of the lack of necessity of sprinkling any street however much traffic it carries. The traffic on this avenue is so concentrated that it would be impracticable to run sprinkling wagons over it even if the city desired to do so, and yet the pavement is always clean and never dusty.

A simple object lesson is the fact that when, contrary to a practice of keeping pavement surfaces continually wet down by sprinkling wagons, a portion of the surface has become dry for a time, it is found to be clean, while the still wet portions of the surface are still covered with a nasty, slimy, slippery mud.

The asphalt pavement on Alexander street, Rochester, in the laying of which I was plant foreman, in 1884 and 1885, is still in existence, and has a record for low cost of repairs which has been repeatedly referred to in reports to this association, and has until quite recently been free from street sprinkling. I was in Rochester about ten days ago and found the sprinkling cart has gotten in its work on Alexander street, and it is now rapidly deteriorating. Rutger street, Utica, laid in 1886, has been thru a similar experience of no sprinkling. Michigan boulevard, Chicago, from Jackson boulevard to Tenth street, paved partly with creosoted wood blocks and partly with asphalt, was always in dry condition and carried a very heavy traffic for ten years, and was in good condition when,

about four years ago, it was removed on account of widening the street, necessitated by the great increase in volume of traffic.

The bituminous pavement on Michigan avenue, Chicago, is now nearly five miles long. By actual count on July 26, 1912, it then carried a daily traffic of 11,425 vehicles, which has probably now increased to at least 14,000 vehicles per day. The pavement surface is always clean and never cleaned or sprinkled other than patrol cleaning, except as to narrow strips, about four feet wide, which are sprinkled and hand-broomed at night to remove the slight dirt which naturally collects near the curb. Other boulevards in Chicago are similarly treated, and confirm what is said above regarding New York City and further confirm the experience of Providence and the statement made above that a modern pavement surface requires little cleaning and will always be clean if it is only kept dry and hand patrolled thru the day.

I hope the day is not far distant when our cities generally will adopt a modern system of street cleaning without sprinkling, following the recent revolution from dirt streets to modern pavements and from horse-drawn to motor traffic. Providence has led the way. Other cities will do well to follow.

Vitrified Brick Street Construction.

By Will P. Blair, Cleveland, Ohio.

EVERY practical precaution must be taken to preserve the sub-base in a continued dry state to a depth below the probable frost line. If there be no frost line, the requirement of drainage is not so essential, the reason for the drainage being, to provide against expansion and rupture which follows with low temperature if moisture is present. For the purpose of securing a dry condition of the sub-base, it is useless to drain with little fall or to carry any great distance a supply of water underneath the pavement. The water from underneath the pavement must be carried thru transverse or triangular drains as quickly as the greatest fall practical will permit. From a slow-moving flow by capillary attraction the moisture is drawn up into the soil or earth and the drain is of no use whatever. The surplus water must be carried to points of disposal thru tile side drains or sewers located as far distant from underneath the pavement and as far below the frost line as possible. Only in this manner is it possible to eliminate the injury to pavements due to low temperature and much of that due to high temperature.

If the sub-base is dry, it furnishes a better support. If a concrete foundation is used, such drainage will prevent the intermittent wet and dry or contracting and expanding, that cracks and ruptures. During seasons of very high temperature, it takes away the hazard of a rupture from the expanding force of heat and steam.

A crown in a street serves but one purpose—that of surface drainage. What little therefore is needed for that purpose had better be provided in the artificial foundation with a flat bottom and crowned top.

The sub-base, once made, let it remain so. It should remain as a permanent and everlasting investment undisturbed, and not as is sometimes unfortunately the case, injured by hauling over it materials that go into other parts of the improvement. It is a crime to utterly destroy this part of the improvement before the public has any use of it whatever.

For reasons given for a uniform sub-base corresponding with that of the finished street, the concrete base must be finished likewise. This is easily accomplished as illustrated by making the mix sufficiently wet to be spread with the back of a dirt shovel or a shovel made for the special purpose and slightly heavier. (See

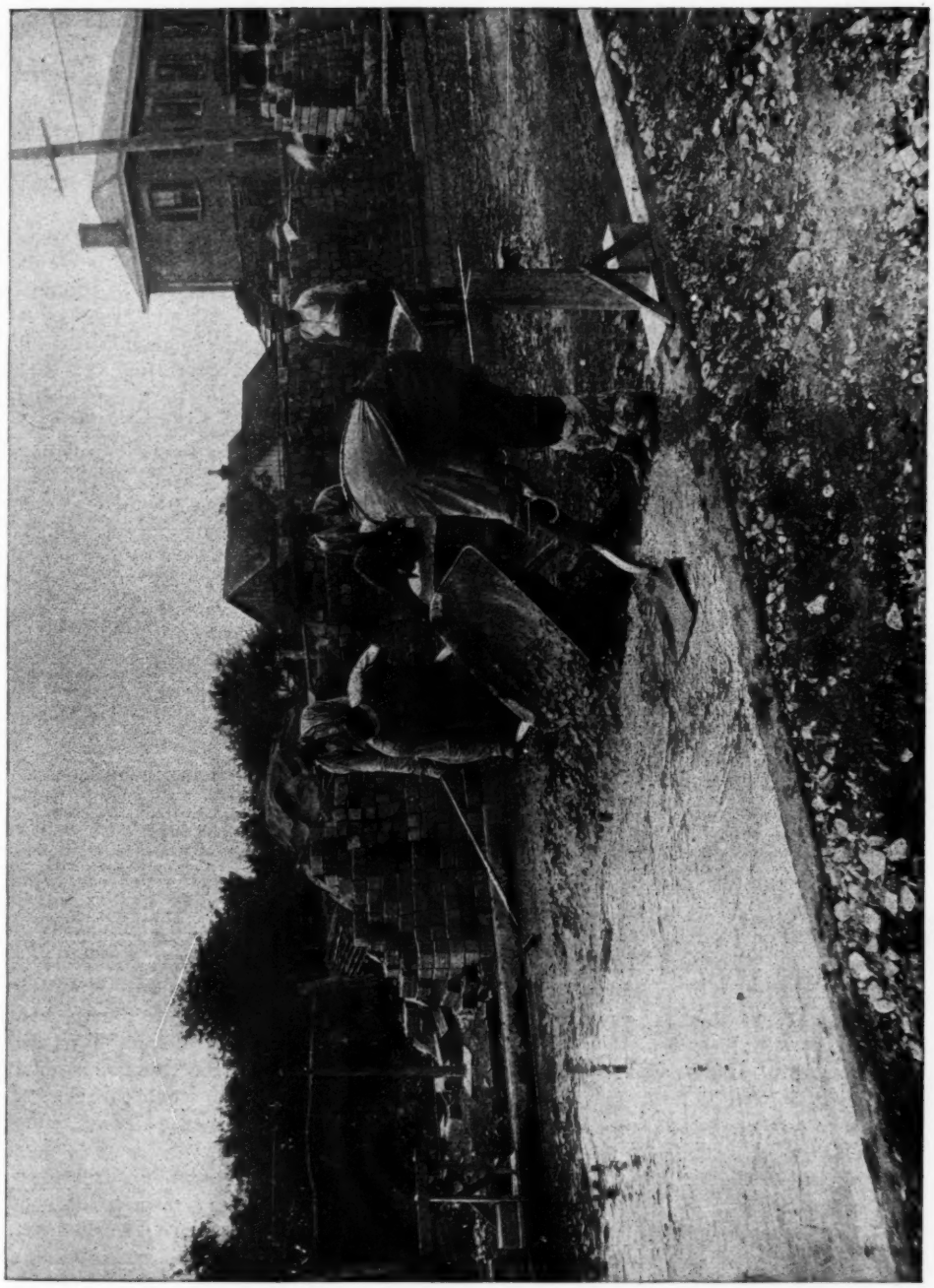


Fig. 1. Consistency of concrete required for best results.

Fig. 1). A guide template is greatly to be preferred over stakes to test the accuracy desired for a smooth grade and cross section.

The proper application and function of the sand cushion overlying the foundation base seems to be little understood; many specifications do not require it to be rolled and when it is provided for, but little importance is attached to it. Two real fights between the contractor and the engineer and many disputes over the interpretation of the requirement for rolling and compression of the cushion took place in the presence of the writer this season. The sand cushion must be made to furnish a uniform and even support to the wearing face of the brick that is to be built upon it. Its compaction and uniformity must be accomplished before the brick are placed upon it. It must be rolled, possibly dampened and re-rolled, struck off and re-rolled and depressions filled until it presents an approach to a solid or at least reduces to a minimum the voids in the sand. (See Fig. 2). A mere smoothing of the top of the sand cushion, affording a support here and there, will not suffice, nor will it do at all to depend upon compressing this cushion as an incident to rolling the brick. The attempt to roll the sand cushion transversely over the crown is almost fatal to good results. It is unnecessary that the quality of the sand for this cushion should conform to either purity, sharpness, fineness or even freedom from soil. Uniformity in its character and freedom from refuse and pebbles is essential. Suitable sand for the cushion therefore is readily obtainable at reasonable cost in all parts of the country.

Whatever may be said of the durability of the brick in their service as a wearing surface, it is well to bear in mind that the entire preparation of sub-grade, foundation and all else ready for the reception of the brick by the exercise of care, both in the preparation of the specifications and in their execution, the work thus far may be regarded as a permanent part of the improvement. If proper care is exercised as to detail, it would be a most remote happening that any part of the work should sustain an injury and necessitate a repair in any way. It is highly important therefore and surely in the interest of economy that all details of the plan be carried out to the utmost and the plan itself be such as to include in it everything necessary.

It is well known that many things of a mechanical nature are only best done in one way. Certain it is that placing the brick on the sand cushion can only be done best in one way—the best edge must be uppermost.

The brick must be placed for the dropper or brick layer so that this result will follow as a matter of fact in the natural way of picking it up and dropping it in place. Someone else must place them in readiness for this operation and that duty must devolve upon the laborers who bring the brick to him from the pile along the street. The practice of first dropping the brick into the street and depending afterwards upon taking them out and turning them over should no more be allowed than a mason in building a wall should first place a brick the wrong edge out for no apparent reason than to provide the necessity of relaying it. In street work, turning the brick disturbs the sand cushion and in wall work the mortar bed is injured, and in case of both the value of the construction is greatly lessened.

The brick must be clean when placed in the street. I recently knew of a case where the contractor having been on his job almost daily, allowed his men to throw dirt during the excavation process upon the brick, disregarded the fact, and put the brick into the street unwashed. On the completion of the street, the contractor was so proud of it that he invited the writer to go over it with him to inspect it. It did look good and I did not have the courage to say to him that the bond would shatter and the street would be greatly marred in appearance and lesser value made apparent. In less than a year's time the bond of the cement filler was broken and the abutting property owners are contesting the payment for the work. The contractor was one old in experience but he had not learned that a film of dirt will prevent the cement filler from adhering to the brick. It is needless to say that the neglect here lay equally upon both contractor and engineer. As a matter of

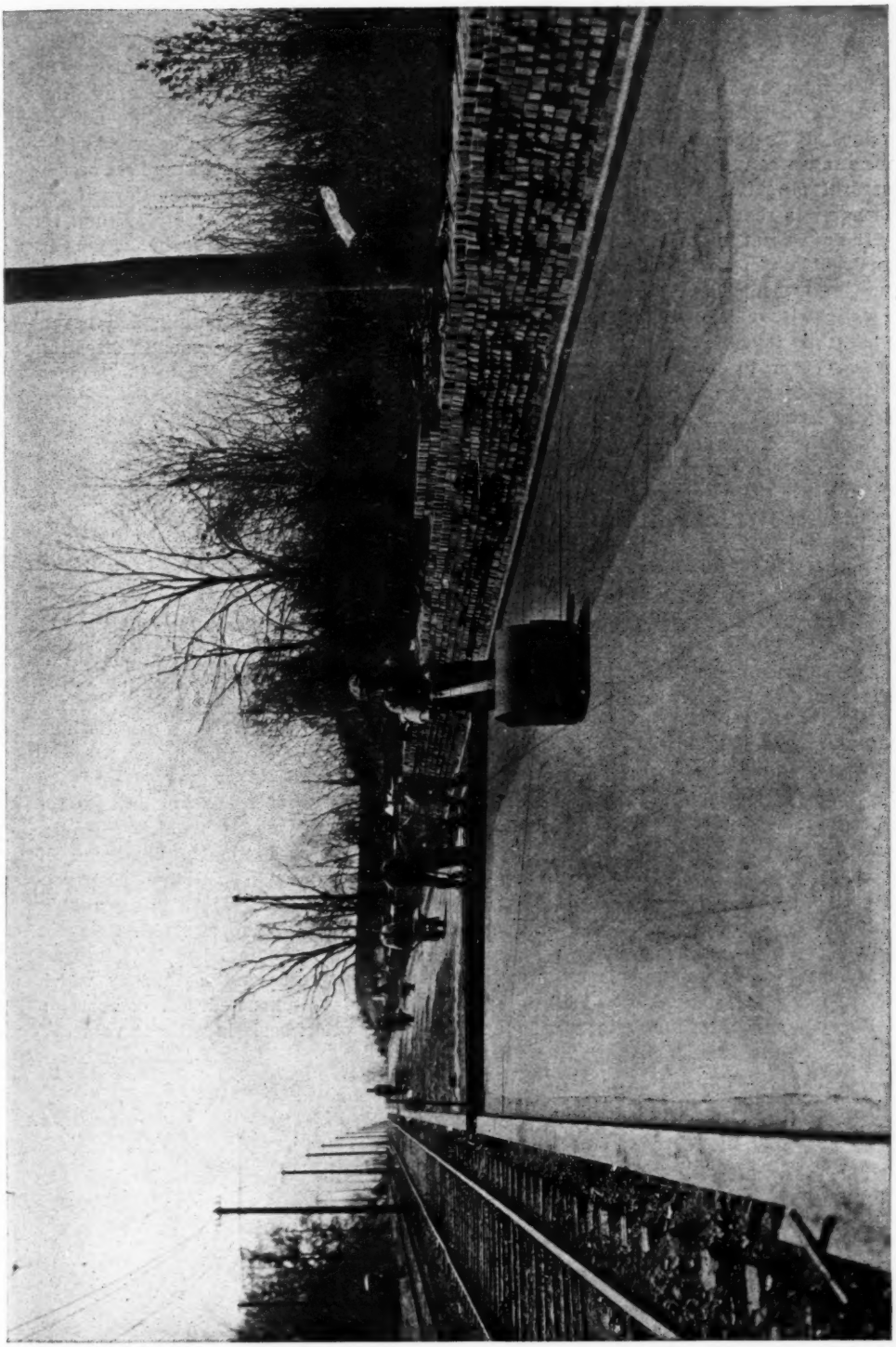


Fig. 2. Thoro compression of sand cushion essential.

economy, the brick should be placed at right angles with the curb line. I have no patience with the fancied theory that brick or stone lying in the street north, south, east or west or in picture form, adds to or detracts from their wearing value. It is the physical advantage for resisting wear, impact and elements of natural climatic effects that counts for economy in road construction.

It does seem an easy matter to follow our well-known directions for the application of cement filler. The trouble does not lie with a lack of understanding or that it is difficult. Failures result from a disposition to do it some other way so that negative directions seem almost necessary as well as positive ones. The object of the filler is to unite the brick units and make the pavement monolithic and thus reduce the wear practically to one of friction and distribute the load to the widest era. It must therefore be hard, tough and adhesive and as nearly impervious as possible and of uniform strength. To secure these qualities we find:

The mixture must be one to one of fine sharp sand and the best quality of cement.

That it must be mixed and applied to maintain these proportions in place.

That it must be applied to a dampened brick surface to make it adhere.

That it must extend solidly thru the entire interstices of the pavement.

It is impossible to call attention to all negative instructions or suggestions. Many things are done that ought not to be done which seem improbable. But a few days since, on a job where almost every step in construction approached the ideal, an intelligent appearing young man was found sprinkling the second coat of filler that had become slightly too stiff in shoving it forward in the second coat, washing off the cement coating from the sand particles instead of thinning by an intermixture of very thin consistency. A cement filler having been properly applied, do not expose it, do not allow it to be wrecked by an exposure to either extreme heat or violent changes of temperature. Cover it up and protect it so that in its setting, its maximum strength will result.

It is not expected this paper will do more than indicate the best practice in brick street and road building. I nevertheless trust I have succeeded in directing your serious consideration to the importance from the illustrations here given (Figs. 3 and 4). The one is a busy street built upon a concrete foundation of six inches and bearing as heavy traffic for eight years last past as can be found in our American cities of 200,000 population. The other, a street built upon the natural soil without an artificial foundation and bearing an average traffic in the residential district for ten years last past.

The importance of correct plans and proper execution of work where reasonable care has been exercised may be further appreciated from the results here given.

We have undertaken to measure the economic value of roads and streets for many years by merely naming them by the kind of predominating material of which they are made. In view of our presentation, I am constrained to say that it is a waste of time to assemble data for economic values unless you take into account the manner and method by which the road is constructed. A comparison upon any other basis is without value.

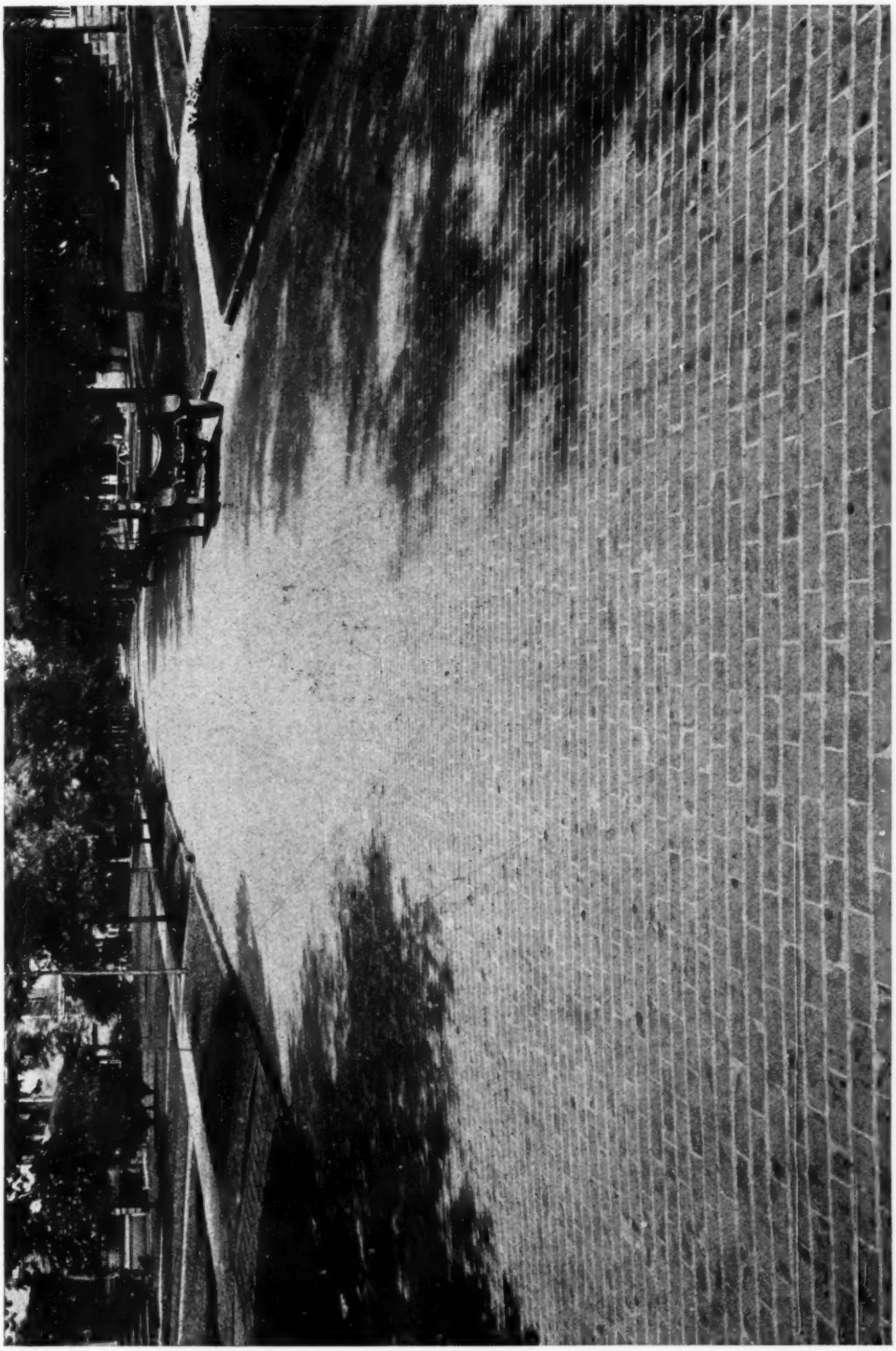


Fig. 3. A busy brick street on concrete foundation, eight years old.

Fig. 4. A good brick street in residential district on natural soil foundation, ten years old.

CITY AND COUNTY HIGHWAY DRAINAGE

By Frank Reed, Los Angeles, California.

Corrugated iron and concrete are the two most popular materials for constructing drainage channels under roads and railroads and like purposes in California, and this article is prepared after a careful study of the conditions of such work in Southern California, where flood emergencies call for special characteristics. It also gives the results of experience under ordinary city and county highway conditions.

DRAINAGE is as much a question of economics as of engineering. Economics makes engineering interesting by placing a dollar doubt beside every assumed balance of forces. When such doubts are reduced, those charged with the wise distribution of the expenditures of a civic body enjoy peace of mind. Past experience is the best guide to the future, but not a perfect one. Destruction sometimes visits the works of the best of engineers. This may be because they have not foreseen the precise amount and intensity and mode and point of application of the destructive forces. More often they will have realized the possibility of their occurring but decide that the probability was so slight that it would cost too much money to provide a structure able to resist the attack.

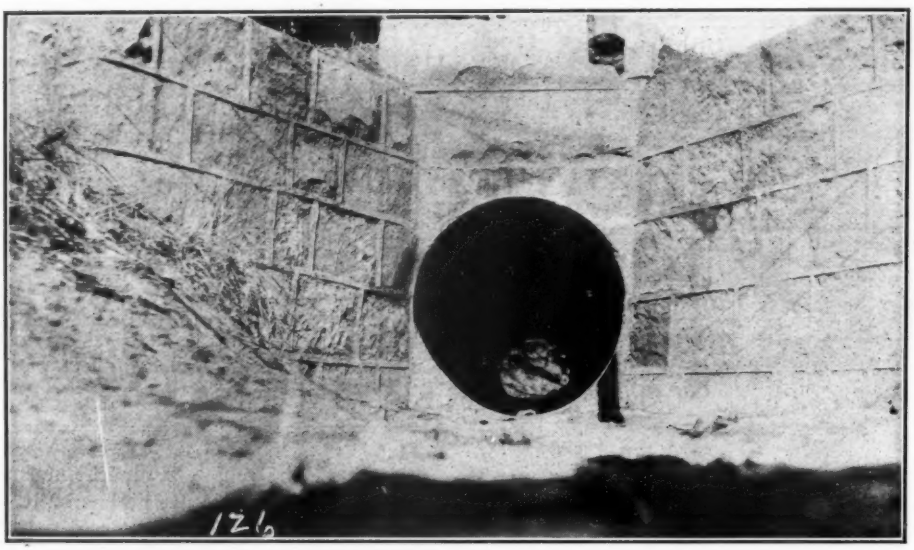
Decisions on type of structure in doubtful cases usually represent not alone the judgment of the engineer, but a composite of his judgment with that of the executive officials of the civic body who make the allotment of the budget. It is an important question, both of detail and of general policy, how far it is good judgment to go toward providing a structure which is strong enough to meet any possible stresses suggested by the experience of exceptional disasters, which occur only once in many years.

Annual charges on invested capital are a certainty. On the other hand, floods, for example, are variable from year to year. There can only be one greatest flood, and its like may not come again during the lifetime of the engineer, or the normal existence of the structure he has built.

The problem then is to insure a reasonably permanent structure at a reasonable cost. Of course, an ideal structure is one which not only provides a good margin of safety at a low proportionate expenditure, but which will behave well and permit of economical replacement, when subjected to the stresses, such as the floods that occurred last year in Ohio, and Indiana, and California, which good financial policy would not warrant the engineer in providing against with a structure of certain permanence.

Corrugated iron culverts behaved well in last year's flood emergencies. They stayed in place where everything else washed out. Elsewhere they gave a good answer to the question, "Suppose it does go, how much is lost in delay to traffic and replacement expense?" The big corrugated iron tubes rode down stream undamaged in floods, were dragged back with mules or horses and buried in earth and were carrying traffic in record time and with record economy. No special materials, no special outfit, and no special labor were required for their replacement. Just ordinary earth work, and ordinary labor to handle the teaming of the culverts, and of the earth work, and its shoveling and tamping. And the hasty temporary replacement became a part of the new and permanent structure. It did not have to be ripped out and wasted incidentally to the permanent repair.

So corrugated iron culverts and drains



CORRUGATED IRON CULVERT *near Montecito, Santa Barbara county, California, showing the attention paid to detail and appearance by County Supervisor H. S. Deaderich. This culvert is 3 feet in diameter and 34 feet long.*

have claimed special attention since these disasters, and investigation has brought out a greater appreciation of the ordinary, everyday good points, which have won for this type of structure a steadily increasing use and support among engineers responsible for the best type of city, rural and mountain highway construction, as well as by their professional colleagues in the steam and electric railway fields and elsewhere.

A series of questions were distributed by the writer among representative municipal engineers of California, where culverts get hard service tests, with the view of ascertaining their experience with, and judgment on the use of corrugated iron culverts. The replies, without exception, indicated their use during a sufficient time to enable users to come to a settled judgment, an increasing use of this type of culvert, and a state of satisfaction with it.

In drain and culvert practice, the round corrugated iron culvert has been installed in a great variety of conditions and sizes, from 8-inch to 84-inch, and gages of iron No. 16 to No. 10. Part circle culverts are meeting with an increasing use where side drains and intersections must be built in such a manner as to secure the necessary strength with the least possible depth of structure. They enable the engineer to take care of the flow of water by providing a broad rather than a deep conduit.

Features of this latter type of construction have been well described in an article by Mr. Paul E. Kressly covering his work as engineer at Inglewood, Cal.

In side drain work, situations where economy of the corrugated iron culvert and the ease of placing it are noticeable, are at intersections, with an interesting type occurring where the culverts are laid under the sidewalk across the corner, giving a clear, dry footway; under drives to abutting property; ordinary culvert construction for carrying streams and drainage beneath roads. Under these latter conditions, of course, the larger sizes of pipe, and usually the greater lengths are employed. Where it is necessary to work in a small vertical space, a part circle may be used, or, more easily, a battery of tubes of moderate diameter avoids disturbing the level of the highway. With the small tubes special care must be taken to avoid the risk of under-estimating capacity, as several small pipes are more likely to be choked at the ends with large sticks and stones, and carrying capacity for water is more likely to be insufficient.

In the West, where irrigating ditches present a problem to the county highway engineer, the inverted siphon of corrugated iron is giving splendid service. Experience has shown that it does not clog from muddy water, and in the event of a change of location of a ditch the culvert may be moved without loss of material to the county. It abolishes the nuisance of the high ditch crossing, and broken planks and constant maintenance of wood culverts, as has been the experience of Mr. F. E. Lester, highway commissioner, stated in a published report on the highway system built for his county of Dona Ana, N. M.

A few motor truck owners object to restrictive ordinances, some of which are possibly due to poor judgment as to what they start down a highway. A western gas company owns a truck which carried nine tons of material as far as a bridge and went thru the bridge, as they boast, "Without hurting the truck." Corrugated culverts used on highways have been subjected to big loads and frequent travel of trucks which were not foreseen when the highways were built. But the material has not only strength to resist compression, but elasticity which takes care of impact and the heavy dragging tension which characterizes the rapid passing of a truck. The strength is high in proportion to weight and gage, due to the corrugated form, as is likewise the elasticity. Equally satisfactory is the resistance to stresses from the inside, caused by freezing of water in the pipe in winter. As the pipes are joined together by fitting one section within the end of another, the joint has double strength, giving proper resistance to stresses from freezing, as well as external stresses, and preventing sections from separating and dropping out of line, due to washed foundations. If end walls are omitted, or inadequate, the end sections do not break off due to progressive washing away of dirt below the pipe. Experience has shown effects of poor filling and unskilled labor will be taken up to some extent by the pipe, as it will conform to some change in its foundation and surrounding earth work, without losing its roundness of section, and a slight sag does not cause choking. It is good in swamps, or quicksands.

The corrugations produce upon solid material passing thru the culvert in water an effect which prevents choking, and also reduces wear on the pipe. They maintain a state of agitation in the water which keeps, silt, etc., in suspension, while sand and sharp stones pass thru with a rolling rather than a sliding motion. The corrugations absorb expansion and contraction due to temperature, so there is no longitudinal thrust tending to break joints and disturb foundations and end walls.

Flow of seepage water immediately beneath or alongside the pipe, which, if present, would gradually drag out the foundations, is to a considerable extent prevented by the corrugations.

CORRUGATED IRON CULVERT *under a main street of Santa Cruz, Cal. This culvert is five feet in diameter and the water falls about five feet at its lower end.*

CORRUGATED IRON CULVERT *under Western Pacific Railway, near Altamont, Cal., 5 feet in diameter and 530 feet long, under a fill 85 feet deep. Two other forms of culvert failed prior to the adoption of the present American ingot iron corrugated circular form.*

On all highways where there is considerable risk of washout, and where the cost of the highway is sufficient to justify it, end walls or rather wing walls, which serve both to protect the ends of the culvert and to concentrate the flow of water, giving a larger capacity, should be used. Nevertheless thousands of culverts are installed, particularly in the rural districts, without any such protection, and under many conditions they seem to give perfect service.

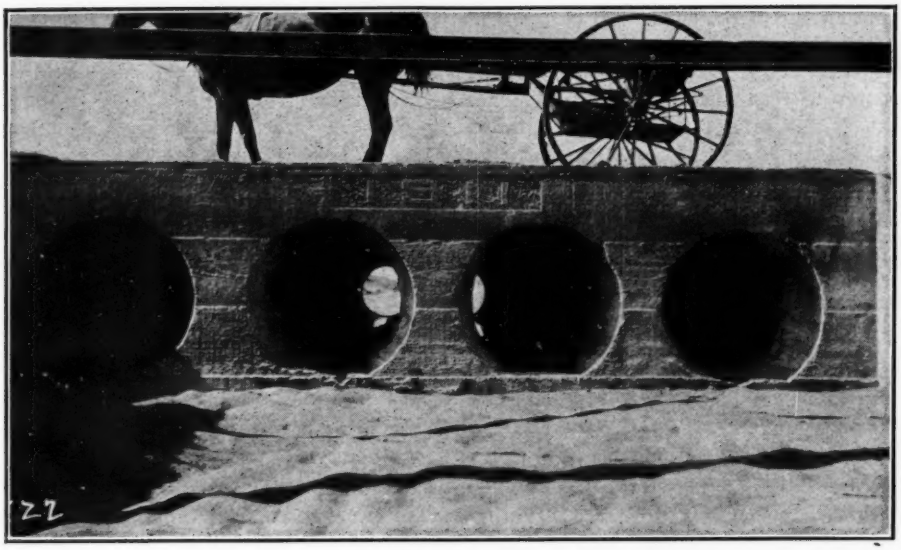
Having become accustomed to the use of corrugated iron in culverts and drains, municipal and county engineers have been experimenting with its application to other purposes, to which the form, and more particularly the durability of the material, make it especially adapted. Corrugated iron tube bridge piers filled with concrete have successfully withstood a flood test, remaining in place when all the rest of the bridge was completely carried out.

Corrugated iron arches are being used by some engineers as a flooring for I-beam highway bridges, the advantages being a considerable reduction of dead load, and economy in construction. All that is necessary is to fit the segments into the space between the I-beams and insure the permanence of the arch by setting the space between the I-beam and the lower part of the segment with grout and covering with road material and surface. The fact that there are no forms to remove (as is likewise true in the case of the part circle drains), reduces the cost materially.

The use of corrugated iron segments to protect the abutments of a bridge against washouts affords an economical method of guarding against this danger. That it is also effective is indicated by the experience in San Bernardino county, Cal., where this type of protection is employed, using plans of County Surveyor J. Shirley Bright, Jr.

Corrugated pipe as a protecting jacket for gas or water mains where these are subjected to traffic have proven highly successful. The Midway Gas Company used many thousands of feet of corrugated iron culvert pipe, 12 inches in diameter, to enclose their 10-inch smooth pipe used to conduct natural gas from the oil fields near Bakersfield to the city of Los Angeles. Whenever the line passed beneath a highway, street, or railroad crossing,

CORRUGATED IRON SEGMENTS *used to protect abutments of bridge against washouts near Chino, San Bernardino county, California. Samuel Pines, supervisor; J. Shirley Bright, Jr., county surveyor.*



FOUR PARALLEL CULVERTS *of American ingot iron, 2 feet in diameter, 30 feet long. Discharge capacity was increased nearly 15 per cent. by beveling the entrances in the concrete end walls.*

the corrugated jackets were used. The Southern California Gas Company, of Los Angeles, has also used this product in similar manner for encasing its distributing mains where traffic was encountered.

On account of its lightness, and the fact that the various sizes will nest one within another, corrugated iron culvert is easily stored and transported. Freight charges are comparatively low, and the cost of local distribution is likewise low, while in the case of small jobs or repair work, the lightness of the culvert makes speed possible in getting it to the point where it is to be used, as well as in the matter of installation. The pipe is delivered all made up and has simply to be rolled into place. If the total length wanted is too long to make its shipment in one length practicable, the fewest number of sections are used and the matter of field joints may be handled easily in several ways. In a busy highway, half the culvert can be installed and traffic can be passed over it while work is being done upon filling the other half. This is an advantage appreciated by the public, as well as by the authorities doing the work.

It is generally agreed that corrugated iron culvert, by its durability, strength, elasticity and other intrinsic advantages, shows a peculiar ability to make good in spite of defects in placing and filling of a mincr character which always occur under the practical conditions of labor and supervision which prevail in road work. Engineers responding to the interrogatories sent out by the writer have given specific replies showing some of the mistakes which could be avoided. In the case of the part-circle culvert, they confirm the warning which is emphatically issued by the manufacturers, as well as suggested by engineering knowledge and common sense, that the sides should fit accurately against the abutting wall, preferably using angle-irons, so that the side wall will be true to line and grade. It must be remembered that the strength of this type of culvert depends almost wholly upon the firmness and rigidity with which its edges are held. Manholes should be left where needed for clean-outs, and culverts should not be made too shallow. Thoro tamping of back filling at the side of a round culvert, particularly the larger diameters, is a point to which careful supervision should be given. Culvert should be so installed that seams are on the sides, to

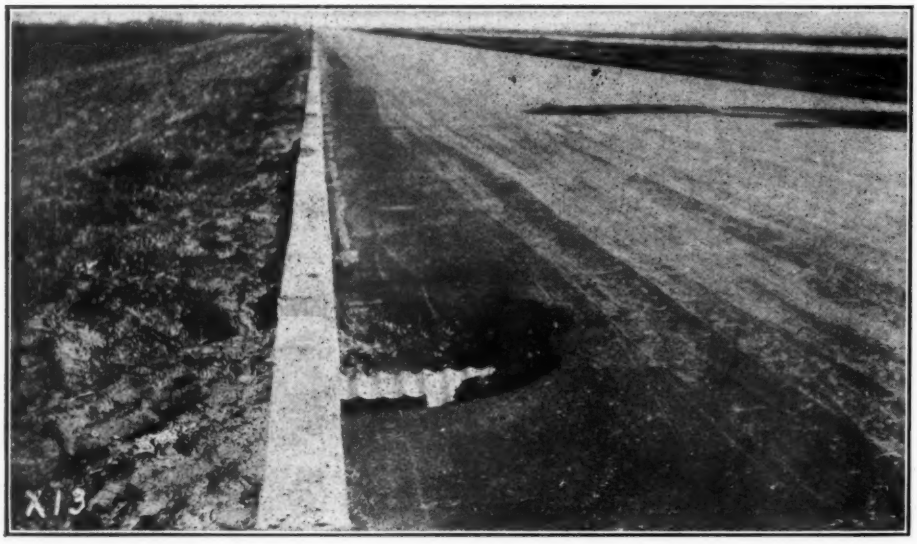
avoid having direct downward thrust bear on the rivets. Covering should never be less than six inches. This thickness or greater will so distribute ordinary loads that engineers are justified in claiming a guarantee from the manufacturer that proper gage will stand up.

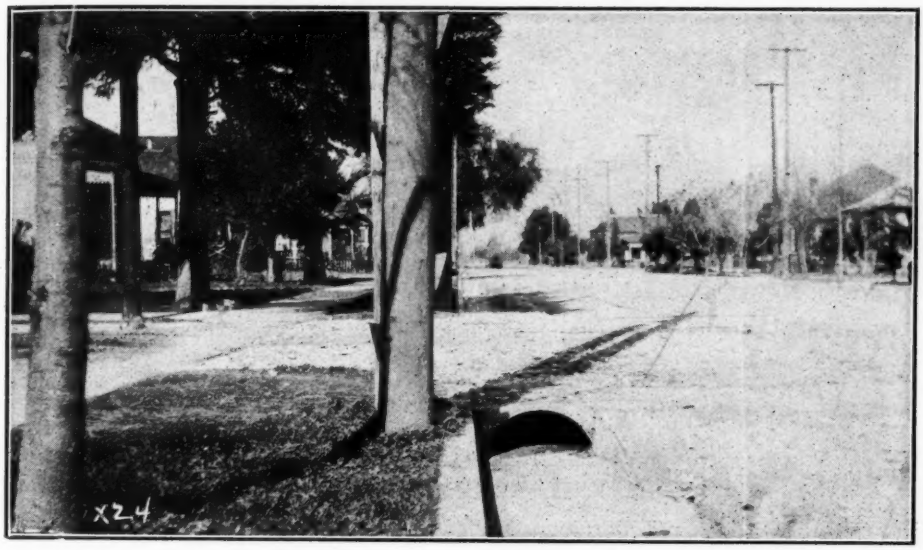
The California Highway Commission and also various California counties and municipalities have adopted a plan assuring durable pipe in highways which would seem to leave no loophole for defective material to be slipped thru, as sometimes happens where pipe is required to be furnished by contractors along with other work. The direct purchase of materials of known merit and required standard is proving a success in California and elsewhere. Contractors unable to bid on work involving purchase of large quantities of material are often able to easily handle the same work efficiently if relieved from the necessity of making arrangement for large capital. The commission buys its own pipe, and along with other work lets out the contract for placing it under suitable specifications.

CORRUGATED IRON CULVERT *under improved roadway near Lankershim, installed by Los Angeles Suburban Homes Company, 10 inches in diameter. Note the opening under the gutter, 5 by 12 inches, cut to receive the gutter drainage.*

This precaution is dictated by the necessity of securing pure iron in order to have a durable pipe. Corrugated iron culverts, like most manufactured products, have seen their wild-cat days, and have been thru the period of over-promotion, prior to reaching their present status of time-proven standards.

The first corrugated culverts were very fortunately made of a very pure charcoal iron, and some of these are still in service in the neighborhood of Crawfordsville, Ind., and in good condition after eighteen years in the ground. After the very early days of pioneering the obvious good points of corrugated iron pipe culverts make it rather easy to sell them, and a good many people got into the business without really understanding what a pipe must be to give long service. Under the influence of too keen price competition and ignorance on the part of both manufacturers and buyers, a great deal of pipe was put in which rusted out rapidly and gave the business a severe set-back, from which it only recovered under the influence of new men and new and scientific methods. It is now recognized that the electrolytic nature of corrosion accounts for the rapid spotting and deterioration of corrugated iron pipes which contain too large a percentage of impurities. This explanation has been accepted by prominent authorities, including the leading tech-





CORRUGATED IRON CULVERT *at street intersection in San Bernardino, Cal. One of many part-circle culverts, specially adapted for such work, where depth is not available.*

nical journals. The tendency of physical science for the past ten years has been to establish the fact that all chemical actions are, in their essence, electro-chemical. The electrolytic corrosion of iron and steel is by no means an isolated or peculiar phenomenon, but is found to be of the same basic nature as the most familiar reactions. The subject has been thoroughly threshed out since the important investigation in 1905, by the U. S. Department of Agriculture, which led to the conclusion that fence wire which deteriorated rapidly did so on account of the presence of segregated impurities, while wire which actual experience showed to have a long life, was very nearly pure iron. It was determined that the purity of the iron was the direct cause of the long life. Corrosion of the short-lived specimens was due to the presence of material occupying a different position from iron on the scale of electro-potential, thus tending to create an electrical condition which favored the oxidation of the iron at points contaminated by the presence of the foreign metal. Pure iron pipe has been used in alkali country and in localities where a considerable variety of mineral substances were present, and has shown a marked superiority in behavior, as far as is noticeable, being unaffected under the influence of alternate washing and drying, warmth and cold, etc.

The proportion of foreign substances in even the lower grades of steel which have been used sometimes in culvert manufacture is very small, and slight variation produces a very considerable change in the ability of the metal to resist corrosion. Formerly the sulphuric acid test was used to detect presence of impurities, but this test does not operate in iron which has been treated with a little copper. Engineers are safe in getting out a specification which goes to the heart of the matter. As pure iron is the metal which lasts, tho absolute purity is impossible, the thing to do is to fix upon the percentage of impurity which can be allowed without promoting deterioration of the pipe, and which is obtainable without undue cost in manufacture, and specify that or greater purity, and get a suitable guarantee. Of course, there is more to a culvert than the raw material. The treatment, including the galvanizing, which is done with a high degree of perfection on some of the culvert in the market, demands careful consideration. So does the assembling, including the width of overlap, which should be sufficient to give a firm joint, and the riveting.

THE COLORADO STREET BRIDGE

AT PASADENA, CALIFORNIA

In the new Colorado street bridge at Pasadena, Cal., the application of structural forms to the design of a concrete structure has been carried so far that engineers are watching the bridge with interest. The pronounced curve near one end adds another item of interest. The engineers have made every provision which their science presents for the action of forces of all sorts which might be applied, and the result will doubtless be a confirmation of their judgment.

ONE of the most pronounced examples of application of structural forms to reinforced concrete is the Colorado st. bridge over the Arroyo Seco, on the city limits of Pasadena, Cal., which was constructed between June, 1912, and December, 1913, and is now in regular use.

The accompanying photographs show the light and graceful appearance of the bridge and its effect upon the landscape, which is one of the most striking in Southern California.

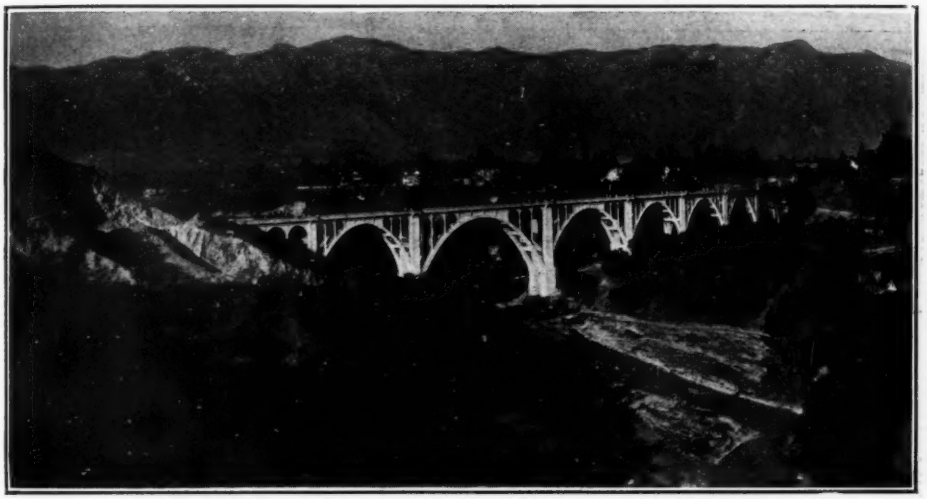
The bridge has nine main arch spans and approach spans at each end broken into three short arches, each of 30 feet span, counting eleven main spans in all, with a total length of 1,467.5 feet, including these approaches. The roadway is 28 feet in width with a 5-foot sidewalk in each side. The longest span, over the main bed of the Arroyo, seen in all three of the accompanying photographs, is 223 feet between centers of piers, and the sidewalk on it is 150 feet above the bed of the water course.

The contract price of the bridge was $187,700, and the total cost, including engineer's fees and extra work, was about $202,000.

Waddell & Harrington, consulting engineers, Kansas City, Mo., were the designers of the bridge and supervised its construction by the contractors, the Mersereau Bridge and Construction Co., of Los Angeles, Cal. We are indebted to L. C. Smith, city engineer, an article by J. C. Wright, chief engineer for the contractors and others for the information and photographs on which this article is based.

The curve in the line of the bridge is a point of interest in the design as well as in the architectural appearance of the bridge, and was used to make the most economical crossing of the Arroyo possible under the existing conditions. The independent foundations for the ribs of the arches and the consequent concentrations of stresses, made the design comparatively simple. The method of tying the tops of piers together, as well as the arch ribs at fixed intervals, is seen clearly in the photographs. The roadway was paved with asphalt and an unexpected difficulty developed in the curve, the pavement becoming very slippery after a light shower. Three wrecks in fifteen minutes is one reported record, all caused by the skidding of automobiles on the curve. Tests showed that the curve is safe at any speed under the legal maximum of ten miles an hour but is dangerous at any greater speed. Flushing the pavement so as to keep it clean, stopped the skidding at reasonable speed. A contributing cause, in one direction, to this difficulty is the gradient of the roadway, which is uniformly 2.655 per cent. from end to end.

The two arch ribs are located under the curb lines of the roadway and the sidewalks are supported on cantilevers or

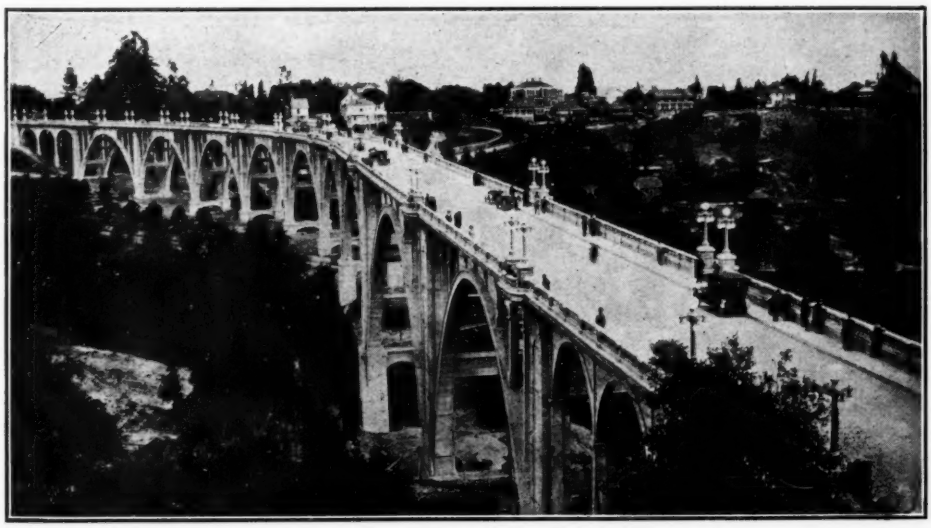


brackets. Over each pier is a recess projecting beyond the outside of the sidewalk, having the appearance of a refuge. The bridge is lighted by two five-light ornamental electroliers at each refuge, these posts and their concrete bases being the only projections above the line of the balustrade.

The city of Pasadena paid half the cost of the bridge and the county of Los Angeles the other half, as it forms the connecting link between Colorado street, the main thorofare of Pasadena and one of the main highways in the comprehensive system of roads improved by the county. Before the bridge was constructed these two highways stopped abruptly at the tops of the bluffs, the ends being about 1,500 feet apart. Narrow, zigzag roads down the bluffs made a very unsatisfactory connec-

COLORADO STREET BRIDGE, *Pasadena, Cal., showing the roadway and lighting system and the character of the roadway and sidewalk traffic.*

COLORADO STREET BRIDGE, *Pasadena, Cal., giving a side view of the entire bridge, with the curve at the right end.*



COLORADO STREET BRIDGE, *Pasadena, Cal., showing the main 210-foot span and the height of the bridge above the bottom of the Arroyo.*

tion, which was badly served by an old timber truss over the water way of the Arroyo.

The curve in the plan of the bridge has a radius of 916 feet, using the center line of the roadway, and a curvature of 52 degrees. Mr. Wright's description of the lay-out of the curve is as follows:

"The center of each pier is on a radial line. The piers are so constructed that the difference in length of the two sides is taken up in them, the two ribs of the arches being identical. This gives each pier a trapezoidal shape. The piers are not solid from face to face of bridge, but a separate pier is constructed for each rib; the separate piers being connected below the springing lines by concrete arch diaphragms 8 feet in width, well reinforced and braced against torsion. The tops of the piers are tied together by braced girders. On the curved portion of the bridge, the entire curve is taken up in the railway and floor system and cantilever brackets, the remaining portions of the piers and arches being constructed on rectangular lines.

"The arches for the 105, 140, and 210-ft. spans are of the fixed type with parabolic intrados. In the 105-ft. span, each rib is 2 ft. deep by 3 ft. 8 in. wide at the crown and 3 ft. 6 in. deep by 4 ft. 8½ in. wide at the springing line.

"In the 140-ft. span each rib is 2 ft. 6 in. deep by 4 ft. wide at the crown and 4 ft. 6 in. deep by 5 ft. 10 in. wide at the springing line. In the 210-ft. span each rib is 3 ft. 8 in. deep by 5 ft. wide at the crown and is 6 ft. 4 in. deep by 6 ft. 6⅜ in. wide at the springing line.

"The arch ribs in each span are tied to each other by six tie beams, placed at regular intervals in the span and at the crown by a cross girder of the floor system. The deck system is of the type known as hollow spandrel construction. Each span is divided into ten panels by cross girders, supported by columns resting on the arch ribs. These cross girders in the 105-ft. span are 14 by 45 in. except at expansion joints where they are 14 by 69 inches.

"In the 140-ft. span the girders are 16 by 53 in. except at expansion joints where they are 16 by 74 in. In the 210-ft. span, the girders are 20 by 63 in. and 20 by 80 in. respectively. The floor slab on the roadway ranges from 9 to 11 in. thick in the various spans."

BUILDING AUSTRALIA'S NEW CAPITAL

By W. D. Hornaday, Austin, Texas.

This description of the plans for the new capital city of Australia and the progress in construction show the part which city planning art in the United States is to play. Australia is on the eve of a rapid development which may bring the completion of this project earlier than is now generally expected.

WHEN I stood on the almost unoccupied and barren site of Canberra, the future great capital city of Australia, it was easy to bring to my mental vision a picture of the possible future appearance of the population and government center that will in years to come cover that undulating plain and valley. Perhaps another Washington or a second Paris, or a modern counterpart of some other great capital city, may occupy that chosen site. Australia is destined to become one of the great nations of the world. It is unreasonable to think that that far-away island-continent, with potentialities that are almost unsurpassed by any of the growing countries of today, will always remain a colonial possession of Great Britain.

When the federation of the six states and territories that comprise the area of Australia was effected in 1900 and a national government thereby established, it was provided that the capital should not be located in any of the existing cities and towns, but that it should be newly established from the ground up.

It is interesting to note that the bringing about of a union of the independent political divisions of Australia and particularly in the accomplishment of many of the preliminary details relating to the location and building of the capital city for the commonwealth, one man of the progressive American type was the most important factor. This person was King O'Malley, who occupied the high position of Minister of State for Home Affairs during the time that the selection of the capital city and the plans for the future great metropolis were under consideration. Mr. O'Malley comes so near being an American by birth, sentiment and action that he is quite generally put in that class of nationalities by the people of Australia. He was born in Canada just across the line from Vermont. He became a resident of the United States, however, when a youth and he lived in this country for many years and until he was sent to Australia as a representative of a life insurance company. There he soon became affiliated with the union labor cause and has been ever since probably the most influential leader of that element, particularly in its political operations. Mr. O'Malley became Minister of State for Home when the Labor party obtained control of the government a few years ago. That party is now ousted from power. Mr. O'Malley is still a member of Parliament, representing a strong labor district in Tasmania. He has impressed his Americanism upon many of the laws of the commonwealth.

It is but natural that it gave Mr. O'Malley no little pleasure, while he occupied the position at the head of the Home Affairs Department, to acept the design of W. B. Griffin, landscape artist of Chicago, for the laying out of the proposed federal capital city. This was a competitive award, Mr. Griffin receiving a premium of $8,750. The designs for the plan of the capital were called for by the commonwealth government in April, 1911. Landscape artists from all over the world entered the competition, a total of 137 designs being received. The board that was appointed to pass upon the competitive

KING O'MALLEY, *a former citizen of the United States, under whose administration the location of the capital was secured and by whom the site was selected.*

plans was unable to make a selection and it devolved upon Mr. O'Malley to make the award.

On acount of the long-standing jealousy that exists between the cities of Sydney and Melbourne and to a more or less degree between the peoples of New South Wales and Victoria, the proposition of establishing a commonwealth government and the creating of a national capital was strongly opposed in certain quarters. Finally, in order that New South Wales might be brought into line, it was stipulated in an act of the constitution of the Australian commonwealth that the seat of government should be determined by Parliament and should be in the state of New South Wales and be distant not less than 100 miles from Sydney. The location of the proposed Federal district and new city were decided upon in 1908. They are in the southern part of the state of New South Wales.

It was on March 12, 1913, that the foundation stones of Canberra, which is the name selected for the national capital city, were laid. The ceremony was impressive and full of official splendor. Among the noted guests were Lord Denman, the Governor-General of Australia, Lady Denman and many of the higher officers of the Commonwealth government. Notwithstanding the remoteness of the locality and the lack of a direct railroad transportation outlet at the time, nearly 5,000 people witnessed the cornerstone ceremony. Of these about 500 were specially invited guests. The brilliancy of the spectacle was enhanced by the presence of about 1,000 colonial troops. The name of the future city was kept a secret. It was left to Lady Denman to confer the title upon the Federal municipality. She carefully guarded the name and did not make it public until that part of the foundation ceremony had been reached when she was called upon to pronounce the name, Canberra, by which it was hereafter to be known.

Yass-Canberra is the name of the district in which the new Federal territory is situated.

Since what is known as the commencement monument, which marked the beginning of the work of building the city, was erected, considerable progress has been made in laying out the capital on the magnificent lines that are embraced in Mr. Griffin's plans. The work at present is largely of an engineering character. Besides the city itself, the Commonwealth government proposes to make the federal territory one of the most modern in its arrangements that is to be found in any country in the world. In order that the commonwealth might have an unbroken outlet to the sea on the east, the Federal area extends to Jervis bay and embraces an ideal deep water harbor and site for a splendid port. It is proposed to develop this new port. This improvement of itself will be of vast benefit to the people of a big scope of territory in the states of New South Wales and Victoria. From Canberra to Sydney is 203 miles, via Quenbeyan, and from Canberra to Melbourne, via Yass, is about 434 miles. When the site of Canberra was selected that locality was not penetrated by a railroad. Since

then a line has been constructed which gives it a direct outlet to Sydney and Melbourne and intermediate points, and by the time the new buildings are erected and the new seat of government established there will have been constructed a railroad from Canberra to Jervis Bay.

Many things were taken into consideration in deciding upon the site for the capital city. From a climatic and health standpoint the Canberra section is unsurpassed in all Australia. The lay of the land, upon which the city is to be built, is specially adapted for carrying to fulfillment the artistic plans which Mr. Griffin has prepared. In the distance are ranges of low mountains, and the slopes of the plains enable the placing in effect of perfect systems of drainage. Every detail of the city that is to be, has been carefully considered and adopted. This applies to the conservation and distribution of the fresh water supply, to the construction of sewer and drainage systems, the laying out of streets, avenues, parks, public gardens and various other public works. Besides the ample supply of water for domestic purposes from the Cotter river, lakes will be created in the city by the construction of dams on the Molonglo river. It is estimated that the available water supply from the Cotter river is sufficient for a population of 250,000. This is exclusive of the catchment area of the Molonglo and Queanbeyan rivers, which may be utilized should the city attain a size demanding it.

All of the public utilities of Canberra, and other towns that are to be established by the commonwealth government on Jervis Bay, including the port, are to be owned and under the direct jurisdiction of the Federal government. Electric power will be generated on the Snowy river, transmitted to Canberra and other points in the Federal territory for domestic and industrial uses.

This city will be different in many respects from any municipality in the world. It is planned to make it not only a center of government for Australia, but to establish there institutions of art and learning and to create a social atmosphere among the people that will make Canberra re-

THE BEAUTIFUL SITE *of Canberra, the new capital of the Federation of the States of Australia.*

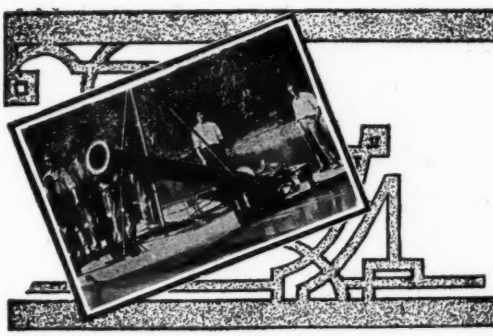
COMMENCEMENT MONUMENT, *marking the beginning of the work of building the Australian capital city of Canberra.*

nowned for its high standard of citizenship. Many millions of dollars are to be expended in the erection of the various government buildings. Every effort is to be put forth in selecting plans for these different structures that will be in full keeping with the landscape design and of the general modernness of the whole scheme. The furnishing of competitive plans for these buildings will be called for and architects all over the world will be allowed to compete. Canberra is to be distinctively a residential city outside of the functions of government that will have their headquarters there. None of the land embraced in the city itself, as well as that in the Federal territory, will be sold. It will be occupied under lease.

The commonwealth government will exercise jurisdiction in prescribing the character of improvements that lessees shall make and in many other ways a careful paternalistic policy will be practiced. It is proposed to utilize a considerable part of the lands outside of the city by locating what is known as closer settlements thereon. These colonies will be aided financially, and in other ways, by the commonwealth government in much the same manner that some of the state governments of Australia are now doing towards settlers upon smaller blocks of public lands. By leasing the land for homes and other purposes instead of selling it, there will be no room for speculation on the part of investors.

At the present time the population of Canberra consists almost exclusively of the administrative officers and force of laborers that are laying off the site and constructing the public utility systems that are to be in readiness for use when the building of the city itself begins. It will take probably several years—how long no one in authority ventures to predict—to complete the public works that are to be the nucleus of the capital. Whether the new city will grow rapidly in population is a matter that time alone can tell.

The layout of Canberra calls for the establishment of a civic and population center to be conveniently located with respect to the railroad station. Wherever possible, the cardinal idea of securing sunlight for the city blocks by planning them at suitable angles to the meridian, has been observed. The Vice-Regal and Prime Minister's residences are to be within easy access of the Parliament building and more ornamental spots of the town. The public office buildings are to be placed around the Parliament house so as to facilitate administration and to lend architectural beauty to the scene. The plans provide adequately for the buildings that are to be used for courts of justice, public worship, university, schools and school playgrounds, hospitals, ornamental lakes, avenues and boulevards, residential areas, lake drives, centers for distributing traffic, streets, facilities for handling freight, tramway system, bridges, provision for city expansion and various other features that go to make up a modern city. The public buildings will be of brick and concrete construction.



EDITORIAL

MUNICIPAL IMPROVEMENTS ARE NOT DIMINISHED BY THE WAR

There are many indications, which are increasing in strength and number daily, that this country is recovering from the shock produced by the declarations of war among European nations and the rapid progress of the war in its earlier stages. The world is beginning to realize that the war will probably last for a long time, and this is having a steadying effect, also. The trade so wantonly abandoned by the warring nations must be taken care of by others, and as time goes on the return of those nations to competition for that trade becomes less dangerous in point of strength as well as of time.

Timid nations and timid manufacturers are becoming daily more ready to go out after the trade waiting for them rather than to wait until it is forced upon them. The questions now are as to how to go to work. Foreign exchange, foreign advertising, foreign conditions of trade and credit, foreign customs and fashions and preferences as to goods and methods of putting them up, are all unknown quantities to the average business man and manufacturer of the United States, and some means must be devised to educate him in these respects. Much is under way for his benefit, but it will take time to put him in the way of shipping his goods to foreign countries with the additional capital probably necessary to begin the new line of credits and to supply the new line of agencies, exhibits and reserve stocks necessary to serve the foreign trade adequately.

Meantime, American business conditions, according to the indications, will be recovering more or less rapidly.

Particular attention should be called to one class of business which is but little disturbed, that of municipal improvements. As is usual in times of financial stress, many cities are proposing to do more than the usual amount of work, for the reason that they wish to reduce the number of

unemployed, and for the further reason that materials and labor under these conditions will probably be less costly and more can be done for the same money than in ordinary times.

Inquiries made of a large number of cities indicate that only a small percentage expect any interference from the effects of the war. Those which can use cash in hand or which can raise money on short time notes are specially busy, because they have no difficulty in getting all the money they want to spend at rates which do not eat up the savings above referred to. Those cities which must raise their money by the sale of improvement bonds are not quite so comfortable just now, because a considerable amount of money is being used to loan at the high rates prevalent in some localities; in short, because the money market is being exploited by bankers and capitalists for their individual benefit.

The adoption of the new banking system, at this time, and the general improvement in conditions, now increasingly apparent, will shortly cure this rather unimportant difficulty. The market for municipal bonds is now the most active of any in long-time securities, because the security behind them is not in the least impaired by the troubles in the business world, and the cities can raise millions where railroads and other corporations can raise thousands.

During the few months which it promises to take to restore normal conditions, it is therefore good business for those supplying suitable machinery and materials to cultivate the municipal field. Even at less than the usual prices it will pay to get this business, for it will tide over until general business improves.

The municipal contractor who must take his pay in improvement bonds may have a little difficulty for a short time in disposing of his bonds and so he may be obliged to restrict his bidding to those places which pay cash. The situation can be eased if the cities which are authorized to do so will issue short time notes, later to be taken up by the issue of long-time bonds. But in any event it will not last long. From this date conditions have changed and the capital now waiting will find its most attractive investments in municipal securities, and this is likely to be the condition for a good many months. It behooves the contractor and manufacturer and dealer in contractors' and municipal machinery and supplies to pay special attention at this time to development of their business in this field.

The *Wall Street Journal,* the *Literary Digest, Engineering and Contracting, The Engineer Contractor, The Nation's Business, The Bond Buyer, The Annalist,* are a few of the more prominent periodicals which have also

made investigations in various lines and report results and opinions similar to those outlined above, making favorable reports regarding the practically undiminished activity in the municipal field, and the probability of material increase in that activity in considerable portions of the field.

STANDARD SPECIFICATIONS

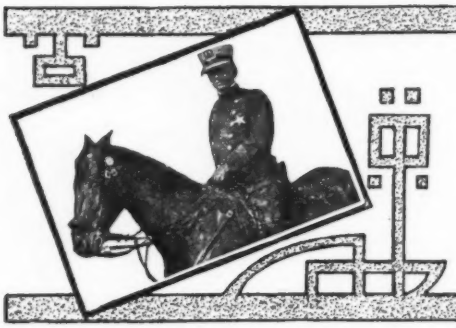
Editorials in the *Engineering Record* criticize the American Society of Municipal Improvements, no longer a small society, for doing the same things for which it approves the American Society for Testing Materials, and, doubtless from lack of information, fail to recognize the open program of discussion of proposed specifications and changes therein, heretofore in use in the former society.

The sub-committees are instructed to prepare specifications and proposed modifications of those previously adopted, with all the aid from all sources that they may desire. These specifications or changes are discussed at meetings beginning the day before the annual convention with the general committee on standard specifications, which is expected to open the discussion to every one interested in them, and has done so. Naturally the talking is done before the committees and but little is left to come before the association, tho there is again an opportunity for full consideration.

Actually, no full specification has ever been adopted by the association without at least one year's discussion and publication in the proceedings of the association, and usually two or three years have been required. It is difficult to see how any procedure could be more open or more carefully safeguarded from undue influences, including the one singled out for attack. This year more changes were up for action than usual, because of the reconciliation of differences between the specifications heretofore adopted by the A. S. M. I. and those of the A. S. P. S., and in two cases these were held up for another year's discussion. But one full new set of specifications was adopted.

The chairman of the general committee on standard specifications and the president of the society evidently agree with the *Record* in one of its positions regarding the principle of action of the American Society for Testing Materials, since they appointed chairmen and members of sub-committees according to that principle as far as the constitution of the society permits, only active members being eligible as working members of committees, aside from some representatives of the A. S. P. S. as provided in the terms of amalgamation.

Motives rather than results have been attacked, no specific charges regarding the latter having been made, and recommendation is made to the *Record* that it make a full investigation, in which case its general reputation for fairness will insure a material amendment of its inconsistent, insufficiently considered criticisms.



QUESTION DEPARTMENT

Makers of Weed Killers

Can you give me tidings of the Atlas Preservative Company of America? Wishing to try some "Weed Killers," I wrote that company, 97 Liberty street, New York, for sample of their Atlas "A" recommended in MUNICIPAL ENGINEERING a couple of years ago, but received no reply. Do you know who manufactures the stuff?

A., ———, Ont.

Can our readers refer our correspondent to the information he wants? Hendricks' Directory gives 95 Liberty as the present address of the Atlas Preservative Company of America, and also lists Horticultural Chemical Company, Bullit building, Philadelphia, Pa., as makers of chemical weed killers.

Books of Municipal Statistics Wanted

Will you kindly furnish us with directory of towns in states of Virginia and Florida, giving statistical data of municipality, population, bonded indebtedness and class of improvements, waterworks, electric lights, sewers and paving, etc.

If you do not furnish these books, please give us the names of people who do.

W., Atlanta, Ga.

Can our readers refer our correspondent to any publication or publications giving all the information he desires?

The U. S. Bureau of the Census publishes data on most of these points for cities of 30,000 population or more, but the writer is not acquainted with any publication which will give them for smaller cities and towns.

Pneumatic Street Cleaning Machines

I would like to know if you know of any pneumatic street cleaning machine. If so, who is it made by and has same proven satisfactory. H., St. Louis, Mo.

The Furnas machine is the only strictly pneumatic machine. The company has a new automobile machine, section of which is shown on p. 181 of the September number of MUNICIPAL ENGINEERING. It is made in Indianapolis, Ind. The Kern street sweeper, made in Sandusky, O., is a new candidate for popular favor. One of these machines is illustrated on the same page and others on p. 108 of the August number, where they are described. This machine has a revolving broom, which throws the street dust into an air current, which drops it in a dirt box, thus using the pneumatic process for removing the dirt swept up by the broom.

A machine on principles somewhat similar is illustrated in vol. xlvi, p. 527, and described in vol. xlv, p. 167.

An Italian so-called vacuum street cleaner is described in vol. xlvi, p. 160, which depends upon the suction produced by the rapid motion of the brush to aid in carrying the dirt swept up into the dirt box on the rear of the machine.

Society of Road Standardization

What is the "Society of Road Standardization of America?" Where is its headquarters and who are its officers" I have just read a newspaper clipping which says that two gentlemen reached Chicago for an initial trip to cover routes running thru seven states.

T., ———, O.

Can any of our readers give us information about this society, if such an association is in existence?

Rates for Sewerage Service

Will you kindly let me know where I can obtain information with regard to rates for sewerage service, whether charged by private sewer companies or by municipalities?

B., ———, N. J.

In MUNICIPAL ENGINEERING, vol. xxxix, p. 40, will be found a list of private sewer systems, with the rates charged by a number of them, and references to a number of earlier articles on the subject. In vol. xlii, p. 328, is a statement of the plan proposed at Vincennes, Ind., for renting sewers of a private company building them, and in vol. xliii, p. 119, is one on Ellsworth, Kans., neither of them giving the rates charged.

There are various methods of making

assessments to pay for the construction of sewers, but very few cities make a continuing charge for the use of public sewers. In addition to assessments of cost, several cities make a charge for connecting with the sewer:

Boston does not assess vacant lots when a sewer is built, but collects a fee of 2 cents a square foot up to 100 feet depth of lot drained when the connection is made.

Richmond, Va., makes an annual assessment of 10 cents a front foot on the abutting property, which may be commuted by paying $1.50 a front foot.

Brockton, Mass., makes a quarterly charge for sewer maintenance of 15 cents per 100 cubic feet of water entering the sewer from private properties.

Taunton, Mass., raises two-thirds the cost of operating and maintaining sewers by sewer rentals or charges and one-third by general taxation.

These cities are all of more than 30,000 population, and data concerning them may be found in Special Report of the Bureau of the Census giving General Statistics of Cities of over 30,000 population for 1909.

Atlantic City is at present the only city of more than 30,000 population whose sewer system is owned by a private corporation.

The various kinds of charges made for sewer service are not well shown in the report above referred to, but the following figures taken from it may be of interest. Receipts from permits for making sewer connections were reported from fifty-eight cities, amounting to $310,632. One city reported receipts of $87,383 for making sewer connections, derived from special assessments, and one reported $81 received for making sewer and water connections. Three cities reported total receipts of $11,995 for privileges of constructing and maintaining private sewers.

The receipts in 1912 of Richmond, Va., on account of fees and charges on the sewer system were $18,261. Those of Brockton, Mass., were $56,845. Those of Taunton, Mass., were $10,576. Those of Boston, Mass., were $23,445.

The only other cities having receipts as large as Taunton are Chicago, Ill., $23,606; Cleveland, O., $17,966; Buffalo, N. Y., $16,082; Newark, N. J., $20,061; Springfield, Mass., $29,532; Galveston, Tex., $22,416.

Several Texas cities have established more or less extended sewer systems by use of private capital, some of which have passed over to public ownership. None of these are contained in the report, as none of them have over 30,000 population. The receipts by Galveston, above reported, indicate that that city makes special collections of some sort for sewer service. Fort Worth received $2,907 and Houston $150 on the same account in 1912. If any of our readers can give information about sewer systems constructed with private capital, and methods of paying for the service in Texas towns or elsewhere, they are requested to give it, as data are difficult to obtain on this subject.

The city of Vincennes, Ind., is recently reported to have chosen the option under the franchise for construction of its sewers by private company, of paying an annual rental which will retire the bonds of the system in twenty-five years, when the system will pass to the ownership of the city. If the city fails to pay the rental, then the company can collect rentals at franchise rates from the citizens using the sewers.

Smoke Consumers

I would like to have full particulars on smoke consumers. Can you give me details concerning efficiency, price, etc.

L. B., ———, Que.

The ter m"smoke consumer" is not now in the best repute, the consumption of smoke after it has been formed not being an economical solution of the smoke problem, and seldom being practicable. Prevention of smoke is the line on which engineers are now working and there are many designs of smokeless furnaces, fuel economizers, and the like, not to mention the simplest methods of feeding a furnace according to its design without over or underloading, locating boiler properly with reference to the fire, making a proper design for the fire box for the work required, the principal objects being to run the furnace regularly and not to overload it, and to feed the fire in such way as to produce no unnecessary smoke.

Among makers of various types of apparatus intended to aid in attaining these objects, including mechanical stokers, are the following, and there are many others, of all grades of cost, efficiency and reliability:

Aeolipyle Co., Chicago, Ill.

American Stoker Co., Erie, Pa.

Babcock & Wilson Co., New York City.

C. O. Bartlett & Snow Co., Cleveland, O.

Casey-Hedges Co., Chattanooga, Tenn.

Erie Foundry Co., Erie, Pa.

Fuel Economizer Engineering Co., Philadelphia, Pa.

Green Engineering Co., Chicago, Ill.

Green Fuel Economizer Co., Matteawan, N. Y.

B. F. Sturtevant Co., Hyde Park, Boston, Mass.

Harrisburg Foundry & Machine Works, Harrisburg, Pa.

Hawley Down Draft Furnace Co., Easton, Pa.

Model Stoker Co., Dayton, O.

Parsons Engineering Co., Wilmington, Del.

Power Specialty Co., 111. Broadway, New York City.

Standard Stoker Co., Wilmington, Del.

Geo. H. Thacher & Co., Albany, N. Y.

Underfeed Stoker Co. of America, Chicago, Ill.

Westinghouse Machine Co., E. Pittsburg, Pa.

Ordinance Regulating Moving Picture Shows

Is it not a fact that most cities have an ordinance prohibiting the conducting of moving picture shows on the second floor of any building? And to what extent do the regulations of cities make the housing of the picture machine fireproof from a fire originating from within same?

H., ———, Ariz.

City regulation of moving picture exhibitions is becoming more strict as the necessities of careful regulation become more evident. The provisions of the ordinance given in the July number of MUNICIPAL ENGINEERING, vol. xlvii, p. 35, seem to be an example, and are none too strict. Sec. 352d., Clause 2, limits location to the ground floor and Clause 7 requires fireproof booths for the moving picture apparatus.

Section 352j provides for the occasional exhibition of moving pictures for educational or religious purposes without charge for admission and for the annulling of the provisions covering moving picture shows proper, except as to the fireproof booth, the licensing authority being given the power and duty to inspect and to determine the restrictions that shall apply, according to the circumstances of the case. Every case of proper exception to the rule seems to be covered by this section and it really errs on the side of leniency, such occasional exhibitions being quite as dangerous while they last as the regular exhibitions, if the conditions of the building are not such that it is fireproof and the exits are ample for the crowds in case of accident.

Who Designs Park Fountains?

In response to the inquiry in the October number of MUNICIPAL ENGINEERING, regarding designers of park fountains, the following information has been received:

Whitehouse and Price, Hutton building, Spokane, Wash., have designed several fountains and other park and garden accessories.

Irving J. Gill was the designer of the electric fountain in the small park opposite the U. S. Grant Hotel, San Diego, Cal.

Lilla P. Taylor, Cottage Grove, Ore., sends a photograph of a small concrete fountain of her design.

Nancy Coonsman, 6191 Delmar boulevard, St. Louis, Mo., won first prize in an open competition for all architects and sculptors in Missouri for the design of a fountain to be built in the sunken gardens in Library park, St. Louis.

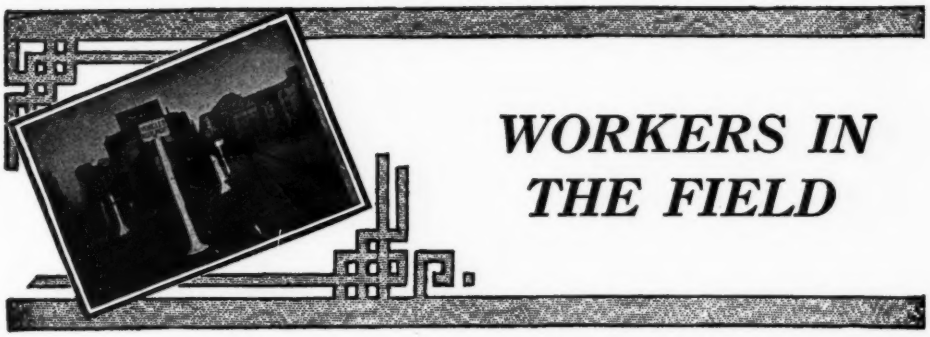
Nitrates May Be Produced in United States

The European situation has called attention sharply to the dependence of this country upon Germany for its potash supply, some 12 or more million dollars' worth of which is used annually in the United States for fertilizer. Another necessary mineral fertilizer for which the United States is entirely dependent upon a foreign country is sodium nitrate, over 21 million dollars' worth of which was imported from Chile last year.

Deposits of sodium and potassium nitrate are known in Utah, Nevada, California, Oregon, Montana and New Mexico, and have been described in publications of the Geological Survey and Bureau of Soils, but thus far no material of this kind has been found in sufficient quantity to promise commercial value. The latest report that has come to the Geological Survey relates to a deposit in Arizona.

One important domestic source of combined nitrogen is the gas works and by-product coke ovens, which in 1912 reported a recovery of ammoniacal liquor, ammonia and ammonium sulphate valued at $9,519,268. This output of by-product ammonium sulphate increased in 10 years from 17,643,507 pounds to 99,070,777 pounds, and as it is linked with the great coking industry further increases can be expected.

Another domestic supply of nitrogen compounds lies in the fixation of atmospheric nitrogen by electricity. Cheap hydroelectric development is necessary to establish this industry, which would make our large agricultural and industrial interests free from the uncertainties of the foreign supply. It is hoped that the water-power legislation now before the United States Senate may promote hydro-electric development in large units and thus utilize some of the great water powers in the West in obtaining nitrogen from the air.



WORKERS IN THE FIELD

Waterproofing Paint for Cement Block Houses

To the list of manufacturers of water-proofing paint for cement block houses, given in the July number of MUNICIPAL ENGINEERING, vol. xlvii, p. 33, should be added the Barrett Manufacturing Company, 17 Battery Place, New York City, who supply a high grade of water-proofing paint.

Trigonometric Tables of Grads

The Editor of MUNICIPAL ENGINEERING:

The question of "L—, Conn." in reference to a table of grads or centesimal divisions of the quadrant, on page 215 of your September issue, has just been brought to my attention.

I have such a table in my possession which may be the book referred to by you in the note following the question, the title being as follows:

"Tables portatives de logarithmes, contenant les logarithmes des nombres depuis 1 jusqua 108,000, les logarithmes des sinus et tangentes de seconde en seconde pour les cinq premier degres, de dix en dix secondes pour tous les degres du quart du cercle; et, suivant la nouvelle division centesimale de dixmillieme en dixmillieme," etc., etc. Par Francois Callet. Edition stereotype. Paris Firmin Didot, Imprimeur du Roi, de l'Institut, et de la marine, etc. 1795 (Tirage 1857).

Besides the more common tables (seven place) of numbers, sines, cosines and tangents, this book contains seven place tables of sines, cosines and tangents in the centesimal division of the quadrant; 20 place tables of common and hyperbolic logs. from 1 to 1200; 20 place tables of logs. with first, second and third differences for numbers from 101,000 to 101,180, and for numbers for logs. from .00000 to .00180; natural sines and cosines and their logs. to 15 places centesimal division; common logs. to 61 places and hyperbolic logs. to 48 places for numbers from 1 to 100, prime numbers from 100 to 1,097, and numbers from 999,980 to 1,000,021; ratios of lengths of degrees to radius taken as unity to 25 places for common and centesimal divisions of quadrant; and other curious and rare tables.

ELLIS B. NOYES,
Portsmouth, Va.

Motor Trucks for Market Delivery

Motor trucks are strongly recommended as a means of preventing the increasing cost of living in Chicago in a preliminary report issued by the Chicago Municipal Markets Commission, appointed by Mayor Harrison.

After showing that the city consumer pays an average of $1.90 for produce that the farmer sells for $1.00, the commission states that it costs more to haul 100 pounds of potatoes, fruit or other farm products five miles from the docks to the city consumer or the retail store than to ship them by boat from Michigan to Chicago, and it costs nearly half as much (50 cents) to deliver a ton of coal from the railroad tracks to the consumer in the business district of the city as it costs to ship the coal 400 miles by rail ($1.05) from southern Illinois to Chicago.

It is estimated that in an area of less than two square miles in the heart of the city 150,000 tons of freight are hauled daily. About 1,000 teams are engaged in hauling food products, exclusive of the delivery service of the retailers, and, to make a profit for their owners, single teams must earn about $6 a day and double teams $8.

"Team hauling is decidedly antiquated, wasteful and inadequate," observes the report. "Because of the congestion existing in the streets of the central business district and the consequent inadequacy of the streets to afford free passage to vehicles, the average wagon or truck spends about one-third of its time actively hauling commodities and two-thirds in waiting, loading, unloading and in delays to traffic.

"Animal transportation is out of place and an archaic survival. Under present methods of hauling, food products are invariably exposed for hours to the heat of the sun. The motor truck as a carrier of food products assures to the consumer better food, lower prices, and a lower cost of hauling. Detailed comparisons showing the cost of hauling by horses and wagons and motor vehicles indicate that the average cost of hauling in the city by motor is 11¼ cents per ton mile as compared with 17¾ cents by horse.

"The average cost of deliveries by department stores, grocery stores and meat markets is shown to be approximately 8 cents by motor and 16 cents by horse."

Automatic Bell Warning at Garage Exit

An interesting bit of "Safety First" work has been put in practice by the proprietor of a garage in Louisville, Kentucky, whose example might well be followed in other places.

Motor vehicles leaving this garage are obliged to cross the sidewalk of a busy street along which pedestrians are passing all hours of the day and night, and as a warning a lamp has been installed in front of the exit in a large globe, on each side of which the word "Danger" is painted in large letters.

This lamp is lighted from sunset to sunrise and in itself forms an effective cautionary signal. It is, however, supplemented by a loud-ringing gong, which is automatically operated whenever a vehicle approaches the exit door, a steel plate being so placed that it automatically closes the contact with a copper spring and rings the bell whenever the wheels pass over it.

Our correspondent writes that it is interesting to note how pedestrians passing along the sidewalk intuitively "stop, look and listen" at the instant the bell begins to ring and wait until the automobile has crossed the sidewalk into the street. It has been suggested that local authorities would do well to enforce the installation of such a device at the entrance to every garage located on busy thorofares.

Improvements in El Paso, Tex.

El Paso, Tex., is growing so rapidly that it is difficult for the construction and engineering departments to keep up with the demands for water pipes, sewers, sidewalks and garbage disposal. The city is building about a half mile of cement sidewalks a month. A two-mile trunk sewer, 36 to 48 inches in diameter, was recently completed in reinforced concrete. The street paving is of different grades of bitulithic. A half mile on North Kansas street is about finished. A reinforced concrete bridge is under construction. George Espy is city engineer and F. H. Todd is consulting engineer. S. H. McMullen is a member of the engineering force.

Electric Light Service for Freeport Texas

Freeport, Tex., has a new electric lighting and power system suitable to meet the needs of this growing seaport. In connection with the new superheated water and power plant installed at the Freeport Sulphur Company's mines at Bryan Heights, a new central electric power plant was included in the plans. This plant, thru transmission lines, will supply electric light and power to Freeport, taking the place of a much smaller plant.

This plant includes a 200-k.w. Westinghouse steam turbine direct connected generator set.

This central power station will do all the work at the mines at Bryan Heights, in operating electric driven pumps to pump water from the canal and fuel oil from the storage tanks on the Freeport ship channel to the mines, providing power for the machine shop and for commercial and domestic lighting and power at Freeport.

Fans For Fighting Fire

We have all heard of fighting fire with fire, but the use of electric fans as an adjunct by a fire department in putting out a blaze is surely novel.

In Boston not long ago, a fire broke out in the basement of a building occupied by a wholesale paint and chemical concern. The fumes and smoke became so thick it was impossible for the firemen to enter the basement or direct a stream with any effectiveness, when someone thought of electric fans. A half dozen of the ordinary 16-inch size were quickly requisitioned by the fire chief and their breeze was directed down the stairway. As soon as the rear basement windows were broken to allow the escape of the smoke and fumes, the effect of the fans gradually cleared the basement so that the firemen could work quickly and effectively in extinguishing the flames.

ROADS AND PAVEMENTS

Repairs to Concrete Pavements

The following brief description of the methods of repairing the concrete pavements in Wayne county, about Detroit, Mich., was written by Frank F. Rogers, the state Highway Engineer of Michigan, and may be taken as authoritative:

Repairs to the Wayne county concrete roadways have mostly been confined to expansion joints, where the edges of the concrete have chipped off, and to the defects above described, which are subject to the same action.

In making repairs, the cracks, whether at expansion joints or other places, are broomed out clean, preferably when the weather is warm and dry, and poured full of hot refined tar. A portable heating kettle is moved along on the pavement and the tar is poured from long nozzled cans, which are fitted with long wooden handles. When filling a joint, the workman backs up, dragging the nozzle of the can along the crack, which is filled about as rapidly as a man can work. As fast as the joints are filled, another laborer follows up and spreads a layer of dry, sharp sand over the tar to a depth of from ¼ to ½-inch. Pit holes, unless large, are filled with tar and sand in the same manner. It might be added that the tars are found to adhere to concrete better than the asphalts.

Repairs of this kind cost about $50 a mile, and have to be repeated each year. They prevent further deterioration of the pavement, both at the transverse joints and at the cracks which nature has formed. In fact, so far, the cracks do not seem to menace the life of the pavements.

In a few places where holes have formed, due to defective mixing or to some foreign substance accidentally getting into the concrete, repairs have been made by chiseling out the concrete down to the subgrade, brooming off the sides, and filling the excavation with concrete of the same kind as used in the original construction. The cost of this kind of repair has been a negligible quantity, as compared with the others.

The transverse joints on the early construction were formed by placing three strips of tar paper between the 25-foot sections. Later, sheared steel plates, separated by strips of tar paper, and having prongs which are bedded in the concrete of the adjoining sections, have been used. So far, there has been little or no chipping of the edges of the concrete next to the steel plates. However, the joints are all kept filled and covered with tar and sand to prevent possible wear.

On two roads, which were completed late in the fall, short sections of the surface become thickly pitted to the depth of ¼ to ½-inch, due to opening the road to traffic before the concrete was thoroly hard. These defects have also been repaired by covering with sand, as in the case of the joints and cracks. This coating has to be renewed when it wears away.

A few sections of the Michigan avenue road, not in need of repair, were tarred and sanded in 1911, to watch results. Only a small part of this was worn off during the first year, but so far, the kind of repairs I have endeavored to describe are all that the Wayne County Road Commissioners have found necessary or advisable.

Paving with Small Granite Blocks

The recent articles in MUNICIPAL ENGINEERING on recut granite blocks in Schenectady, N. Y., and the papers on similar block pavements in the Boro of The Bronx, New York City and in Newark, N. J., before the American Society of Municipal Improvements, one of which will be found elsewhere in this number, are evidence of the present interest in paving with small granite blocks.

The first pavement of this sort in the United States, of which the writer is informed, was laid in Troy, N. Y., in 1907. The next were laid in the Boro of The Bronx in 1909, as described in Mr. Thompson's paper, above referred to. The pavements in Schenectady and in Newark were laid in 1913. Small areas of ragged old granite block paving have been laid in sev-

eral cities such as Philadelphia, Brooklyn, Manhattan, Trenton, N. J., Kearney, N. J., all being quite new, but they are unimportant in amount and most of them not very definite as to specifications for blocks, the old material on hand having been used, napped, chipped or otherwise dressed as seemed simplest, easiest and cheapest.

One form of small granite block paving has been in use in European countries for some thirty years. It is known as Durax in England, and as Kleinpflaster in Germany. A small amount of this paving was laid in 1913 in the U. S. Navy Yard at Brooklyn, N. Y., and some has been laid this year at Salisbury, N. C.

The experience with this paving is reported to be very satisfactory in foreign countries, where it has been in successful use for so many years that its life is confidently stated to be 25 to 30 years, so that a brief description of its characteristics will be of interest. The accompanying photographs give some idea of its appearance and show its most prominent characteristics.

Like every good pavement, Durax should have a good foundation, preferably concrete, proportional to the weight of loads and amount of traffic, tho some excellent automobile and comparatively light traffic roads and streets have been laid on the old macadam as a base.

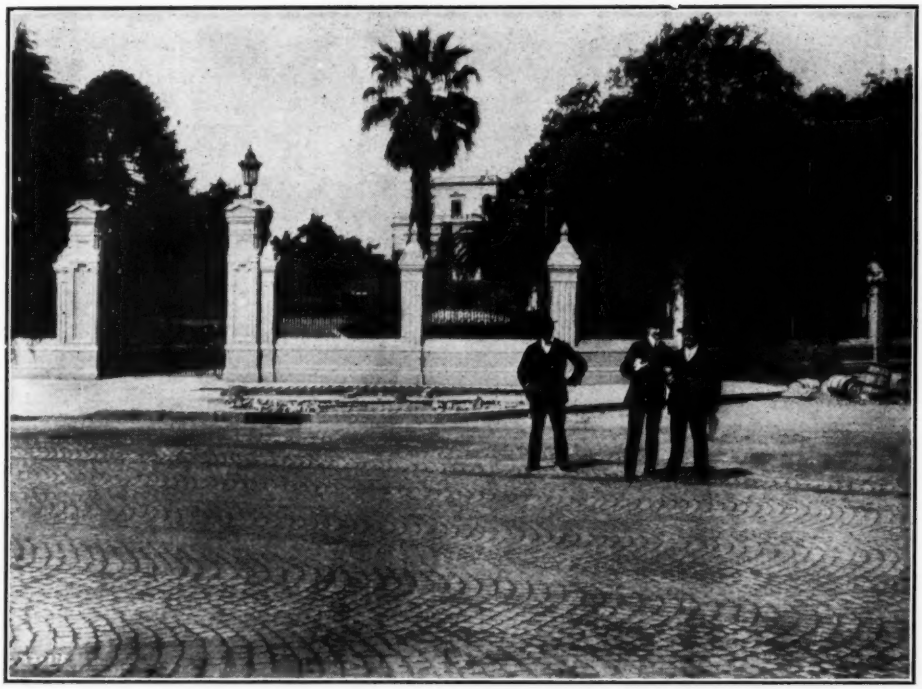
The blocks, as shown in the photographs, are small, and of rather irregularly cubical forms, specifications calling for dimensions between 2¾ and 3½ inches being usual. The sides may taper slightly so that the bases are smaller than the wearing surfaces. Before laying they are sorted to give uniform depths of blocks, the shallowest blocks being used next the curb or outer edges of the road.

The patterns in which the blocks are laid are chosen with the purpose of having no joints lying at right angles to the lines of moving vehicles and so that no two wheels of a vehicle will cross the same joint or course of stone at the same time. This conduces to better foothold for horses and more uniform wear under wheels so as to promote the continuance of a smooth surface.

It is usual to bed the blocks in a cushion of sand or fine stone chips and to use a cement grout filler, thus preventing such defects in design, construction and wear as tilting, riding, formation of waves, disintegration, creeping, crumbling, softening or raveling. Bituminous fillers are also used successfully.

The cost of the pavement is not yet defi-

DURAX PAVEMENT *laid in Munich, Bavaria. Note interweaving of the circular arc patterns in which the blocks are laid. Form and small size of blocks are well shown also.*



DURAX PAVEMENT *on Avenida Alocar Esquina Gallo. Buenos Aires, Argentina, South America.*

nitely known for all conditions. When the Brooklyn Navy Yard pavement was laid, bids were received for 4-inch granite blocks under a very rigid specification as to sizes, for Durax, and for the usual oblong granite paving blocks. The 4-inch blocks laid on existing foundation were bid at $4.98 a square yard, including ½-inch cushion and filler of the same material filled flush with coal tar pitch. The bid on Durax was $3.25 and the bids on the standard oblong block were from $3.28 to $4.68, the former, on the New York City specification being 12 cents less than the bid by the same contractor on the Navy Yard specification. Bids for wood block pavement, received at the same time, were from $2.37 to $3.20.

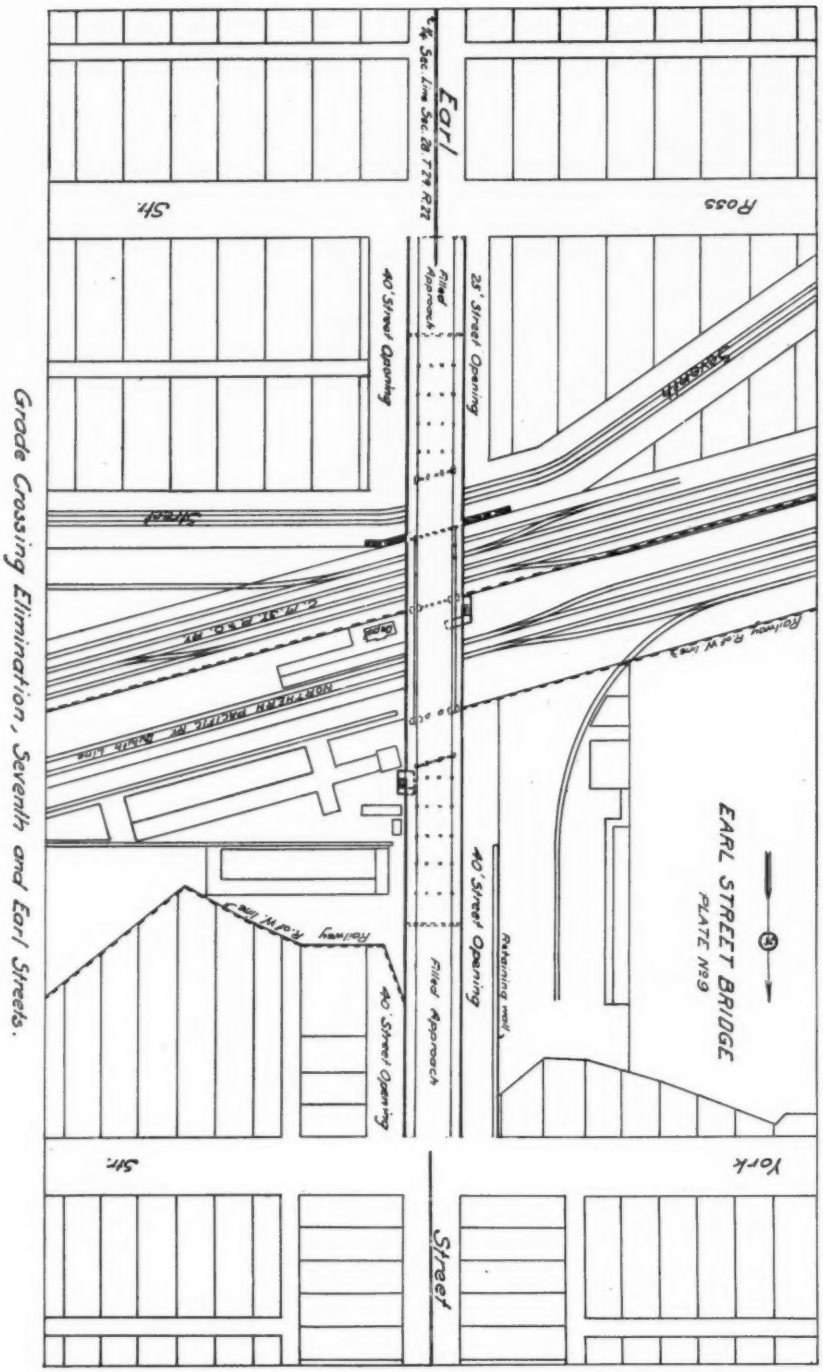
The cost of paving done in Schenectady, including cost of breaking and dressing old blocks, but not including the cost of the original blocks, was $1.52 a square yard. The cost of taking up the old pavement and of taking up the old granite blocks used in the new pavement, was 16 cents a square yard, and the new concrete foundation cost 33 cents a square yard, making the total cost on a typical street, $2.01 a square yard. To the cost of $1.52 a square yard given above must be added the cost of the granite blocks and some part of the cost of cutting them, in order to make the figures comparable with those of the Brooklyn job. It is probable, also, that the hand breaking and dressing in Schenectady was more expensive than the machine cutting of blocks used for the Brooklyn job, a special machine having been devised for cutting granite blocks for Durax paving, at a minimum of cost and of waste of material.

There are no patents on the pavement itself, which is laid thus far in this country by the Wern Stone Paving Co., of New York.

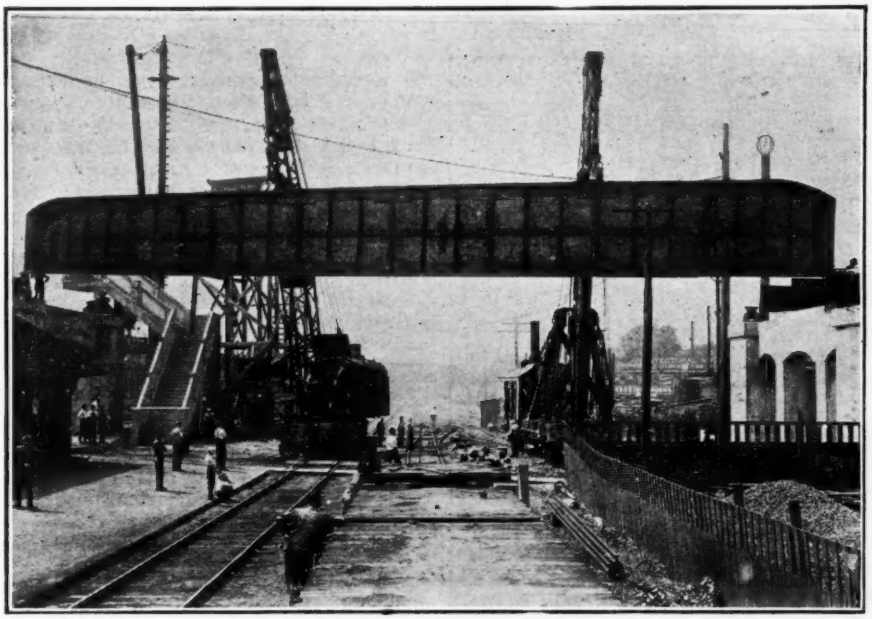
Cost of Supervision of Highway Construction

The following statement shows the annual cost of supervision of construction of highways by the state highway department of Ohio in percentage of the amounts expended by the state in such construction:

1914	4.03%
1912 and 1913	5.71%
1911 and 1912	6.18%
1910 and 1911	6.40%
1909 and 1910	5.39%
1908 and 1909	5.43%
1907 and 1908	5.28%
1906 and 1907	7.55%



Grade Crossing Elimination, Seventh and Earl Streets.



LIFTING A 115-FOOT GIRDER *into its place in the Earl street viaduct.*

The amount of public money expended on highway construction in 1914 has been $6,600,000, of which $3,150,000 came from the state treasury and $3,450,000 from the counties.

The Earl Street Bridge, St. Paul, Minn.

The Earl street bridge in St. Paul, Minn., is a viaduct carrying Earl street over the tracks of the C., M., St. P. & O. and the N. P. railroads and the street railway tracks on Seventh street. The accompanying plan and photograph show clearly the lay-out of the structure. The south approach begins at the north line of Ross street and the north approach at the south line of York street, the total length being 932 feet. The south approach walls are 97 feet long, north approach 211 feet. The southern reinforced concrete trestle is 350 feet long and the northern 180 feet, connecting the filled approaches with the steel spans, which are respectively 65 feet over Seventh street, 73 feet over the C., M., St. P. & O. railroad, 114 feet over the N. P. railroad and 43 feet over a roadway on the north side of the railroad right-of-way. All of the bottom steel in the girders over the railroad tracks is incased in concrete for protection, 590 cubic yards being used for this purpose, with 65,209 pounds of reinforcing steel to hold it in place.

The materials used include the following additional amounts: Concrete in approaching retaining walls, 1,617 cubic yards. Concrete in reinforced concrete trestle, 1,922 cubic yards. Reinforcing steel in retaining walls and trestle, 385,888 pounds. Structural steel in girders, 445 tons. Concrete railing, 575 linear feet.

The viaduct has a 40-foot roadway paved with creosoted wood blocks on the more level portions and with sandstone block on the inclines.

The concrete sidewalks are 8 feet wide. There are two concrete stairways and two steel stairways, one of the former and both of the latter seen in the photographs. The total cost of the structure was $117,000.

The smaller photograph shows the process of placing one of the 115-foot girders. It was brought to the location on flat cars, one of which is seen in the foreground. The two locomotive cranes in the rear picked it up, swung it thru a turn of 90 degrees or so, and are now dropping it on its seats on the piers at either side.

We are indebted to J. E. Carroll, assistant city engineer, and Geo. H. Herrold, office engineer under Oscar Claussen, chief engineer, for the photographs and data given.

VIEW OF EARL STREET VIADUCT *from the west.*

Prison Labor on West Virginia Roads

Success in convict road work is reported from West Virginia. This road work has been developed as the result of legislation passed at the last session of the legislature. Prior to this session Governor Hatfield and representatives of the legislature and supreme court journeyed to New York for conference with the national committee on prisons and prison labor.

At the conference, in which representatives of the department of highway engineering and the bill drafting bureau of Columbia University participated, a state road bureau was planned to co-operate with the state prison department in working the prisoners upon the public roads.

A recent report received by the national committee on prisons and prison labor from A. D. Williams, chairman of the road bureau, states that to date three convict road camps have been established, the men being under the honor system and living in tents. Two of the camps are located on a stream and the men each evening go bathing and enjoy all the liberties of camp life. Three Italians have attempted escape, but the Americans and negroes are proving themselves worthy of trust.

At St. Mary's camp, in solid and loose rock the men have averaged 4.03 cubic yards per day. At the Inwood camp the average was 4.33 cubic yards, which included the erection of one concrete culvert 20 by 30 feet, 27 feet long, and sixteen days' labor for one man out of 118 laying tiling.

A crew of citizen labor was also working at St. Mary's camp on the same work, and an interesting comparison of costs was made. The cost of moving material by citizens was 83 cents per cubic yard, against 30 cents with the prisoners.

These developments indicate that thru road work West Virginia will to a great extent solve her prison problem.

The Filler for Brick Pavements

By G. L. Schomburg.

A problem that is given too little consideration in the construction of brick pavement is the matter of the filler. It would seem, from a number of instances coming under the writer's observation, that the matter of a filler was almost taken for granted, and that "anything will do." Nevertheless, this is a matter that should be given the greatest consideration, for the very success of this type of pavement depends on the filler used.

Brick itself is tough enough but their very nature demands a supporting agent

or an element that will enable them to demonstrate their true worth. If the brick themselves were just laid on the prepared base and nothing further done it would only be a short time until they would be displaced by traffic. It, therefore, becomes necessary to place something between and around the brick to hold them in place. It is necessary that this agent perform other functions in order that it serve its purpose fully. The movements of the pavement caused by contraction and expansion must also be overcome, and further than this the penetration of water and street liquids must be guarded against.

Asphalt filler was first produced in 1898 and its use has increased year after year, until now it is accepted as a standard material for filling the interstices of a brick pavement.

In drawing a set of specifications it is not sufficient to state "The interstices of the brick and all openings around manholes and along the gutter shall be filled flush with an asphalt filler" and stop there. The right start has been made toward the correct filler, but in order to secure an asphalt that will perform the necessary function of a brick filler it is necessary to go further with the chemical and physical requirements of the filler to be used.

The readers of this article who have to do with the drawing of specifications, will agree with the writer that the essential feature of a specification is the limitation placed upon the contractor obliging him to use material of a character which will make a thoroly satisfactory piece of work. The specification is in no proper sense an effort to eliminate competition, but is simply a means of requiring the contractor to supply material of certain tested value as to its fitness for the work.

The following specification for asphalt filler is one that is entirely open, in that it can be met by several of the asphalt fillers now on the market and therefore will admit of competition, and if the material complies in all respects the city or user will be assured of securing an ideal asphalt filler.

The interstices, or joints, of the brick (or block) shall be completely filled with an asphalt filler, which must conform to the following standard of quality:

(1) It shall contain not less than 98 per cent. pure bitumen soluble in carbon disulphide (CS_2).

(2) Of the total amount soluble in carbon disulphide (CS_2) 98½ per cent. shall be soluble in carbon tetrachloride ($C Cl_4$).

(3) When tested with a No. 2 needle weighted with 200 grams operating for one minute at 32 degrees Fahrenheit, it shall have a penetration greater than 25 (Dow method).

(4) When tested with a No. 2 needle weighted with 50 grams operating for five seconds at 115 degrees Fahrenheit, it shall have a penetration not greater than 80.

(5) When tested with a No. 2 needle weighted with 100 grams and operating for five seconds at 77 degrees Fahrenheit, it shall have a penetration between the limits of 35 and 50.

(6) Its specific gravity at 60 degrees Fahrenheit shall be greater than 0.975 and less than unity.

(7) It shall have a melting point not lower than 225 and not greater than 285 degrees Fahrenheit.

The filler shall weight not less than 8 nor more than 8½ pounds per gallon at 60 degrees Fahrenheit.

It shall remain ductile at climatic temperatures to which it shall be subjected, shall be waterproof, acid proof and impervious to street liquids. Shall adhere firmly to the brick (or block) and be pliable rather than rigid, thus providing for expansion, contraction and traffic conditions.

The filler must be heated sufficiently to allow proper pouring (about 400 degrees F.) taken from the kettles in buckets and poured from pouring cans.

The contractor must be equipped with pouring cans especially designed for this purpose.

All joints, at both sides and edges of the bricks (or blocks), must be filled completely by pouring the material directly into and flush with the top. The material as poured, shall be at a temperature of not less than 350 degrees F., nor more than 400 degrees F. As the work progresses and while the material is still hot, there shall be sprinkled over the entire surface a layer of clean, dry sand.

If an asphalt filler having the above characteristics is used it will result in a thoroly waterproof, practically dustless, noiseless and sanitary pavement. The asphalt filler will adhere firmly to the brick and will neither "run" in the summer sun or become brittle and chip in cold winter weather, also protecting the edges of the brick and take care of all contraction and expansion.

To sum it all up; a good asphalt filler will make a brick pavement noiseless, dustless, waterproof and sanitary. Another feature that should appeal to the people at large, is the fact, that the street can be thrown open to traffic immediately after pouring.

An article descriptive of a new type of brick pavement requiring the use of asphalt filler, will be published later.

Improvements in American Paving Practice Suggested by European Experience

A report by George W. Tillson, consulting engineer to the President of the Boro of Brooklyn, N. Y., made as a result of an examination of city streets and pavements in certain European cities, in 1913, has been published. It contains very interesting and profusely illustrated descriptions of pavements in many European cities and makes a number of suggestions for improvement of American pavements based on his observations, from which the following has been selected:

As it has been admitted that the best pavements of this country when laid are as good as those of Europe, and that practically the same materials are used, it might be pertinent to suggest methods of procedure in this country so that the condition of its streets would be improved, and the following are offered:

1. Standard first-class paving material only should be used and the proper material selected for each street.

This suggestion is generally carried out at the present time, except that it does not seem that sufficient care is given to the selection of the right material for any particular street.

2. Work should be done carefully, with special care for small details.

3. The funds for new pavements should be provided in advance, so that at least several months should intervene between the time when it was known what streets would be paved and the carrying out of the work, and an attempt should be made in each case to determine when the work was to be ordered and just when it should be carried out on each particular street.

If this were done corporations and individuals could make definite plans for repairs to any subsurface work that might exist in the streets, and also provide for new construction if any were necessary. It must be admitted, however, that in large cities, where a great amount of work is to be done and where it is necessary to let work to the lowest responsible bidder, it would be difficult to determine this in every case. It would, too, be more difficult in the case of new work than in repaving, as when new work is ordered the demand for its immediate completion is very strong. At the present time the Board of Estimate and Apportionment will not permit an original pavement to be laid unless water, sewer and gas mains have first been constructed, but other subsurface work is often necessary. It is believed, however, that if an earnest attempt were made to determine some time in advance just when work should be done, it could be more nearly accomplished than would seem probable at first thought. The advantages of it, however, are so great that even a partial success would be worth much more than it would cost.

4. The number of openings in the pavement should be reduced to a minimum.

It must be admitted that with the different kinds of subsurface work in the streets of this country, and nearly all being in the roadway, with the general changes that are taking place in the character of business along the streets, many openings in the pavements are necessary. This being the case, it becomes all the more important to reduce this number to a minimum. When mains are laid in the street, openings must be made for their repair, but if, previous to the construction of the pavement, corporations put all of their subsurface structures in good repair, there should not be the necessity to make openings for some time to come. Emergencies, however, will arise when openings must be made, and that condition must be accepted.

The street belongs to the city for its entire width, from property line to property line, and its entire width should be used to the best advantage and not the roadway only.

It must be admitted that it is a proper requirement in our crowded cities to have everything underground that it is possible to place there, but it does seem as if the telephone and electric light companies could work out a scheme by which possibly one connection could be made with the main in the street for each block and subsidiary connections made to this sub-main by property owners in the block without tearing up the roadway pavement.

5. The surface of the pavement should be broken by any foreign construction as little as possible.

Street car tracks are necessary, but they should be built in such a way as to conform as nearly as possible to the surface of the street and so that the pavement can be easily maintained adjacent to them. Manhole heads also tend to vary the surface of the pavement, and while, with the present construction of the underground system, they are necessary, they should be as few as possible and built with the utmost care. This fact is recognized abroad, where manhole heads are much less frequent on the streets than in this country, and in Paris almost none were seen on the streets. In Glasgow and Edinburgh structures to take the place of electrical manholes in the streets are erected on the sidewalk.

6. Repairs should be made promptly and in a first-class manner.

7. The city officials and those of the street car companies should work harmoniously, so that railroad work will be done properly and permanent repairs or necessary reconstruction made at the time the streets are paved.

SANITATION

Sewerage of Vancouver District

Operations have been proceeding without interruption since last December in connection with the first unit of sewerage construction undertaken by the Vancouver and District Joint Sewerage and Drainage Board as part of the immense joint sewer system embracing the entire area of Burrard Peninsula, which includes 55,600 acres, of which only about 10,000 acres are within the present boundaries of Vancouver, the remainder being in New Westminster, South Vancouver, Point Grey and Burnaby.

R. S. Lea, consulting engineer, of Montreal, was retained by a joint committee composed of representatives from each of the municipalities interested—with the exception of New Westminster, to advise them as to a general scheme for the whole peninsula and the best means of constructing and maintaining such a scheme in a state of efficiency. His report, which was submitted early in 1913 and adopted by the committee, advised the formation of a permanent sewerage board, this action being carried out forthwith and duly legalized by the provincial government, which at the same time granted financial assistance in the form of a government guarantee covering the interest on $10,000,000, the sum for which the board is empowered to issue bonds, and $5,000,000 of the principal.

Burrard Peninsula is divided naturally into five drainage areas, which discharge respectively into Burrard Inlet, False Creek, English Bay, Fraser River and Burnaby Lake. Each of these areas was studied as a separate problem in laying out the general scheme, except that the disposal of sewerage from each area was considered in the light of its relation to the other districts or the waters there available for distribution.

The principal discharge into Burrard Inlet will be thru an outfall, located at Clarke Drive, which is to drain an area of 8,250 acres, with an estimated population of 238,000 in 1950. Parts of the area being made tributary to the Clark Drive sewer will drain into False Creek and Burnaby Lake. The initial work now in progress and steadily approaching completion comprises a portion of the Canoe Creek and China Creek sewers, which the board decided to construct by day labor. The expenditure to August 1 was $181,000, distributed as follows: Labor, $114,000; material and stores and plant depreciation, $60,000; plant (present value), $7,000.

The work covers the construction of plain concrete sewers and tunnel and reinforced concrete sewers in open trenches. About 70 per cent. of the construction has been completed to date. Nine shafts of an average depth of 25 feet, and 8 by 8 feet across, were sunk at various points in the tunnel during the early stage of operations, and driving was then commenced in opposite directions from each shaft. Altogether, about 3,500 feet of tunneling has been undertaken in what is known as contract No. 1. About 1,000 feet of this is thru hardpan, most of the remainder being in soft ground, with a small section thru running sand. The cost of the miner's piecework amounted to $5.00 per foot thru rock, and $6.00 in soft ground, or $5.50 per foot on an average. The size of timbers used in the tunnel was 8 by 8 feet for the segment sets, with 2-inch lagging or poling boards. The proportion of concrete used was one part of cement, two of sand and four of ¾-inch gravel. The method of applying the concrete was first to line the lower half of the tunnel from shaft to shaft and then attend to the roof and upper portions, working from opposite directions towards a given center, a concrete mixer being placed at each shaft. No reinforcing was used in the tunnel. The sewers in trenches, however, besides being lined with concrete on the same principle as the tunnel, have been heavily reinforced with ½-inch twisted steel except where the ground in the bottom of the trench was sufficiently hard; in such cases no reinforcing was required in the lower half other than for bonding purposes.

An interesting feature of the excavation for the tunnel was the method of hoisting the dirt thru the shafts and dumping on the adjoining vacant lots by means of a self-dumping Alaska trolley. This trolley is really the outcome of mining in Alaska, where the cost and supply of labor have always been very material considerations. It is carried on a cable, suspended between the shaft and the dump. A chain attached to the rim of the bucket passes thru a loop, which, in turn, slides along a light wire running in a line underneath and parallel to the overhead cable. This loose rope extends down to the bottom of the tunnel shaft, where it is securely fastened during the operation of loading the bucket. As the bucket is filled and raised to the surface, the hoisting sheave comes into contact with a hammer attached to the trolley, thus releasing the trolley and enabling it to travel to the dump, where a trip, bolted on the loose ground wire at this point, abruptly arrests the progress of the suspended chain, the shock of the contact inverting the bucket.

Practically all of the plant used in connection with this work was purchased second-hand and therefore at comparatively low cost, an expenditure of less than $8,000 covering the total outlay under this heading. No difficulty has been encountered in obtaining a sufficient supply of labor since the commencement of operations. A force of about 250 men has been constantly employed, the municipal wage rate of $3.00 per day of eight hours being paid.

The cost system employed on the work was designed by Mr. L. E. Wilson, the resident engineer, and could be conveniently adapted to all classes of construction work. All plant purchased for the job was charged on a rental basis at a rate per day commensurate with the life of same, and at the completion of the work the difference between the shipping value plus the total rental charged, as compared with the original purchase price, would be a debit or credit balance, as the case might be, and apportioned to the section of the job properly chargeable with it. The stores were charged every month directly into each section of the job, wherever possible, and where items of general stores could not be so charged direct for the reason that they would be used more or less on the whole work, then the cost was distributed pro rata between the various sections of the work in the proportion that each section bore to the whole contract, and further subdivided pro rata between concrete and excavation in their respective ratios. All tools, such as picks, shovels, hammers, saws, etc., were treated as general stores, as it was considered these would all be worn out on the work, and any value they might possess at the close of operations could be easily adjusted in the final statement of the cost. Progress statements of the cost, together with plans, were turned in to the chief engineer every month. A stock account was kept of the materials used in concrete and was shown at the top of the monthly cost statement.

Early in the present summer the Vancouver and District Joint Sewerage and Drainage Board decided to proceed with the second unit of its vast scheme, embodied in the estimates under the heading of "immediate construction"—which covers work to be undertaken during the next five years, at a cost of $5,500.000—and tenders for the work, which is known as "contract No. 2," were called, the following being the list of bids submitted by the various firms competing: J. Gault & Co., $396,396.65; Leddingham & Cooper, $376,769.13; engineer's estimate (day labor), $365,000; Union Contracting Co., $348,546.24; engineer's estimate (contract), $348,316.90; Moore & Pethick, $340,100.45; Robt. McLean & Co., $333,646; H. P. Peterson, $332,772.80; Hodgson, King & McPhalen, $309,052.72.

The board awarded the contract to the lowest tenderers, Hodgson, King & McPhalen Bros., of Vancouver, who have made all arrangements for immediately starting active operations. The contract covers the construction of some 2,700 feet of 6-foot 6-inch by 6-foot 6-inch horseshoe section, tunnel sewer, and about 5,000 feet of reinforced concrete sewer trench with vitrified brick invert, ranging from 6 feet 6 inches in diameter to 2 feet 6 inches in diameter, together with about 15,000 feet of reinforced concrete pipe sewer ranging from 42 inches to 24 inches in diameter. The conditions of this contract call for the payment of the municipal wage rate of $3.00 per eight-hour day for all ordinary labor employed. It is estimated that operations in connection with this branch of the scheme, which takes in the Clark Drive outfall area, will require about twelve months to complete.

Further developments contemplated by the board, which have been provided for in the estimates, include the conservation of the natural drainage channels of the Burnaby Lake district, a work that is considered of paramount importance in its relation to the combined system of trunk sewers. Part of this project comprises the deepening and improving of the Brunette River, which is the overflow from Burnaby Lake. The lake itself is a shallow sheet of water with a mean water area of about 430 acres and a maximum depth in the center of 9 feet. It lies between Vancouver and New Westminster, at a point about nine miles east of Vancouver. Owing to the presence of a natural rock dyke which lies across the outlet

to the Brunette River and virtually acts as a dam, the lake overflows its banks and floods the low-lying lands in the vicinity during periods of excessive rainfall. The drainage area, estimated at about 26 square miles, resembles a huge, shallow basin with one side broken—the latter conforming to the end at which the dyke is located. The work to be undertaken will consist of the lowering of the level of this dyke to a depth which will permit of satisfactory draining under any circumstances, and the construction of two intercepters for sewage disposal in the district.—*The Contract Record.*

The Public Bath An Americanizer

The free public bath is cutting a larger and larger figure as a factor in civic improvement. St. Louis is boasting of the recent opening, in one of her parks, of the largest concrete swimming pool in the world. Cleveland bitingly retorts with a detailed description of Lake Erie, claimed by that vigorous Ohio town as its unique asset for bathing purposes. New York might point to the Atlantic Ocean, available for similar purposes and quite largely utilized at Coney Island and elsewhere. Albert Wilhelm, in an article contributed to Modern Sanitation, classes the bath with the school and the church as an aid in Americanizing our foreign population. He says:

"A study of the public baths in the great cities like Boston, New York, Baltimore, Philadelphia, Chicago, St. Paul—the centers of such large communities of foreigners—proves beyond question that water is doing a remarkable work along these lines, especially in connection with the public playgrounds. As might be expected, the majority of bathers at the city baths, especially the open-air places, are of European nationalities, but the proportion is so much larger than the number of Americans that it is notable. Investigation shows that not only the Italian, but the Bohemian, Hungarian, the Pole and other classes composing so many of the work people in the greater cities have such a zest for bathing that in the season they come to the baths literally in throngs, so that one may find the water occupied almost entirely by persons who as yet can not speak a word of English, but are expressing their pleasure and delight in a jargon of tongues.

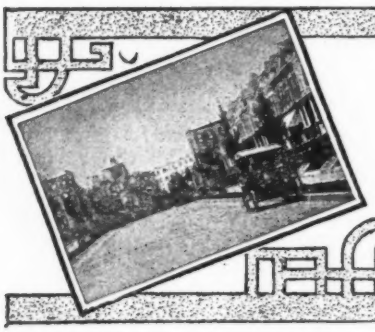
"Boston forms an excellent illustration of the fact that the foreigner takes to the bath not only for enjoyment but for cleanliness and health, and it has a great influence on him for civic betterment. Such a number began to patronize the public baths in this city, especially the seawater baths, when the present season opened, that the officials in charge soon found their facilities for giving baths taxed to the utmost. It had been supposed that the habits of these people were such that they would be averse to going into the water, but the reverse is the case, as shown by the testimony of the men in charge. Citing the various public parks having open-air baths, the superintendents of these baths, men who for the most part have served from ten to fifteen years at their stations, have seen this group of foreign-born patrons, starting with a mere handful a few years ago, swell to proportions which threaten to outgrow the resources of the department. They have noted the changing character of the crowd and have been the ones to report last season and this the noticeable increase of the foreign patronage.

"It will be noted that, while the foreign element monopolizes the baths during a considerable portion of the bathing hours, they are at the same time patronized by the better classes and the Americans—but only when the latter can get a chance to have their exclusive use. The professional and business men have been forced to suit their bathing hours to a time when the others can not be present on account of being at work, and the situation in Boston has aroused such a feeling that those whom we might call American-born are now appealing for baths exclusive to themselves, altho as yet they have not succeeded in securing such facilities at the public expense.

"Social settlement workers and others interested in the uplifting of the tenement districts in the cities all acknowledge that the opportunity to bathe daily if desired has already had a very beneficial effect upon the foreign element, including all the nationalities. It has tended to make them more cleanly in their homes, also in the shops and factories, and has undoubtedly made them more self-respecting.

"In neighborhoods where the majority of the people patronize these bathing places it is noticeable that when they appear on the streets they are neater in their attire, and the women take more pride in the appearance of their homes both inside and outside.

"From the medical standpoint this increase in the use of water at the public expense has done much to lessen the percentage of so-called hot-weather diseases, especially among children, and the city and other physicians acknowledge that it has been a great benefit from a hygienic standpoint. The health board of Chicago has also made a study of the effect of bathing on an extensive scale as provided by the public baths in parks and on the lake front, and has come to the same conclusion."



MISCELLANEOUS

The Boston Convention of the American Society of Municipal Improvements

The American Society of Municipal Improvements celebrated its twenty-first year by the largest convention in its history and one of the most valuable. Owing to the amalgamation with the Association for Standardizing Paving Specifications and the desire to reconcile the differences between the standard specifications heretofore adopted by the two societies, all the specifications were up for consideration. While the necessary changes were slight, they required considerable discussion and the time of the general committee on standard specifications was fully occupied with them from Monday morning until Friday. The results were full sets of specifications from all the sub-committees, all of which were adopted by the association as modified during the discussions before the general committee, except those for wood block pavements and asphaltic concrete, which were reported by the general committee to be unfinished. The committee on asphaltic concrete was given three months to complete its report for publication and distribution preparatory to the discussion at the next convention. The other sets of specifications will be published at once and can be obtained from the secretary within about twenty days.

The convention opened with addresses from Mayor James M. Curley, Col. William D. Sohier, chairman of the Massachusetts state highway commission, and Norman S. Sprague, a vice president of the society. The convention got down to business immediately and under the prompt leadership of President Christ, completed the rather full program on schedule time without cutting off discussion of any subject.

The program printed last month was followed with some additions. Several of the papers mentioned are given in this number of MUNICIPAL ENGINEERING as fully as space allows and others will be given later.

The publication of the volume of proceedings was delayed until receipt of the delayed committee report.

On Monday there was some complaint of lack of opportunity for discussion of specifications before the committee, but this was fully remedied on the following days so that there was but little discussion of the specifications when they were presented to the convention and, with the delay of action concerning two sets of specifications, the expressions of satisfaction with the treatment accorded them were general. One outside complaint is considered in the editorial department.

The inspection and entertainment features of the convention were on a scale commensurate with the reputation of the city of Boston, with unusual weather as an efficient ally. Both the harbor and the automobile trip were of unusual interest and the many trips taken by small parties were quite as instructive as the convention sessions. The programs were so arranged as to devote each session as nearly as possible to a single group of subjects to give the members opportunities for these special trips.

According to custom, the officers were moved up one step, W. A. Howell, of Newark, N. J., becoming president, and A. F. Macallum and N. S. Sprague, first and second vice presidents, E. L. Dalton, of Dallas, Tex., being elected third vice president. Charles C. Brown and W. B. Howe were re-elected as secretary and treasurer. Dayton, O., was selected as the next place of meeting.

The exhibit of materials and machinery used in public improvements was more than usually large and included the products of the following firms:

Better Roads and Streets, Jamestown, O.
Standard Oil Company, Boston, Mass.
Robeson Process Company, Pennington, N. J.
Warren Brothers Company, Boston, Mass.
Municipal Journal, New York, N. Y.
National Brick Manufacturers' Assn., Cleveland, O.
Barrett Mfg. Company, New York and Boston, Mass.

Dunn Wire-Cut-Lug Brick Company, Conneaut, O.
The U. S. Asphalt Refining Co., New York, N. Y.
The Barber Asphalt Paving Co., Philadelphia, Pa.
Headley Good Roads Co., Boston, Mass.
C. L. Berger & Sons, Boston, Mass.
Engineering Record, New York, N. Y.
Lock Joint Pipe Co., Ampere, N. J.
Union Oil Co. of Calif., Chicago, Ill.
American Tar Co., Boston, Mass.
Buffalo Steam Roller Co., Boston, Mass.
Good Roads Magazine, New York, N. Y.
Bauch & Lomb Optical Co., Rochester, N. Y.
Dyar Supply Co., Cambridge, Mass.
Good Roads Machinery Co., Boston, Mass.
Jennison & Wright Co., Toledo, O.
U. S. Wood Preserving Co., New York, N. Y.
Warner-Quinlan Paving Co., New York, N. Y.
Wern Stone Paving Co., New York, N. Y.
The Sanitation Corporation, New York, N. Y.
Engineering News, New York, N. Y.
American Sewer Pipe Co., Boston, Mass.
Frank Ridlon & Co., Boston, Mass.
Universal Road Machinery Co., Kingston, N. Y.
Municipal Engineering, Indianapolis, Ind.

Conference on Industrial Welfare and Efficiency

In accord with the unanimous vote of the first Pennsylvania Industrial Welfare and Efficiency Conference, held in Harrisburg last year, John Price Jackson, Commissioner of Labor and Industry, has issued a call for a second conference, to be held in the State Capitol at Harrisburg on the 17th, 18th and 19th of November, 1914. This conference is held under the auspices of the Pennsylvania Department of Labor and Industry and the Engineers' Society of Pennsylvania. The purpose of the conference is to enable the employers and employes to work out together the great problems before them with reference to increasing the welfare of the employes and the prosperity of the industries.

The conference last year was the most unique and helpful of its kind ever held in the United States. It was attended by approximately two thousand persons, many of whom were leaders in the labor and industrial world. The gathering this year bids fair to have an even larger attendance and to create even more interest than that of last year.

The first session of the conference will be called at 10 a. m., on Tuesday, November 17, and the meetings will close at 5 p. m. on November 19. The various sessions of the conference will be held in the State Capitol, Harrisburg. In connection with the conference proper will be held an unusually effective safety, welfare and efficiency exhibition, which bids fair to be the best of its kind ever held in this country. This will open on the morning of November 16 and close on the evening of November 20.

Technical Schools

The non-resident lecturers in the graduate course in highway engineering at Columbia University appointed for the 1914-1915 session are as follows: John A. Bensel, New York state engineer; Edward D. Boyer, cement and concrete expert, the Atlas Portland Cement Company; Sumner R. Church, manager research department, Barrett Manufacturing Company; William H. Connell, chief Bureau of Highways and Street Cleaning, Philadelphia; W. W. Crosby, chief engineer Maryland Geological and Economic Survey, and consulting engineer; Charles Henry Davis, president National Highways Association; Arthur W. Dean, chief engineer Massachusetts Highway Commission; John H. Delaney, commissioner New York State Department of Efficiency and Economy; A. W. Dow, chemical and consulting paving engineer; H. W. Durham, chief engineer of highways, Boro of Manhattan, New York; C. N. Forrest, chief chemist Barber Asphalt Paving Company; Walter H. Fulweiler, chief chemist United Gas Improvement Company; D. L. Hough, president the United Engineering and Contracting Company; William A. Howell, engineer of streets and highways, Newark; Arthur N. Johnson, highway engineer, Bureau of Municipal Research, New York; Nelson P. Lewis, chief engineer Board of Estimate and Apportionment, New York; Philip P. Sharples, chief chemist Barrett Manufacturing Company; Francis P. Smith, chemical and consulting paving engineer; Albert Sommer, consulting chemist; George W. Tillson, consulting engineer to the president of the Boro of Brooklyn, N. Y.; George C. Warren, president Warren Bros. Company.

Wentworth Institute, Boston, Mass., has issued a catalog, showing among the new developments a course in foundry management and operation. The institute has just finished a new building, nearly doubling its available space.

"Magnetic and Other Properties of Electrolytic Iron Melted in Vacuo," by Trygve D. Yensen, has been issued as Bulletin No. 72 by the Engineering Experiment Station of the University of Illinois. The bulletin shows how it is possible to produce iron of an exceptionally

good magnetic quality by melting pure iron in a vacuum furnace. While iron melted under other conditions is apt to be contaminated by carbon or oxygen to a greater or less extent, iron melted in vacuo is not only prevented from absorbing such impurities, but is actually purified in the process. These facts are illustrated by a large number of curves as well as by numerous photographs showing the crystalline structure of the iron.

"Acoustics of Auditoriums," by F. R. Watson, has been issued as Bulletin No. 73 of the Engineering Experiment Station of the University of Illinois. The bulletin describes the acoustical defects of the auditorium at the University of Illinois, showing graphically in the illustrations the character and paths of various echoes, which were traced by use of an alternating current arc light at the focus of a parabolic reflector, the arc giving forth a hissing sound and the paths of the echoes being located by means of the reflected light and confirmed by means of the sound. A cure for the acoustical defects was found without changing materially the architectural design of the room. The bulletin should be of value to architects and others interested in this subject.

"The Thermal Properties of Steam," by G. A. Goodenough, has been issued as Bulletin No. 75 of the Engineering Experiment Station of the University of Illinois. The bulletin presents a critical discussion of the experimental investigations of the various thermal properties of steam, an outline of the thermodynamic relations that must be satisfied, and, finally, the development of a general theory of superheated and saturated steam. As a basis for such a theory the well-known Munich experiments on specific volumes and specific heats are taken and properly correlated thru the Clausius relation.

Latin American Trade Situation

That Latin American countries are looking to the United States for the capital and the market for their products which they formerly found in Europe is emphasized in "Statements on the Latin American Trade Situation," a pamphlet just issued by the Bureau of Foreign and Domestic Commerce of the Department of Commerce, giving the addresses made by representatives of Latin American countries at a conference with American business men recently held in Washington. The pamphlet, issued as Miscellaneous Series No. 18, contains the statements made by the ministers from Bolivia, Uruguay, Peru and Cuba to the United States, the consuls general of Costa Rica and Colombia in New York, the minister from Ecuador to England, and others, besides the opening remarks of Secretary of State William J. Bryan, and a statement by Secretary of Commerce William C. Redfield. Many obstacles to the development of Latin American trade with the United States were commented on, notably the matter of credits and that of a proper understanding of the Latin American way of doing business on the part of business men in the United States. The pamphlet is for sale by the Superintendent of Documents, Government Printing Office, Washington, for 5 cents.

Civil Service Examinations

The U. S. Civil Service Commission will hold examinations at the usual places, as follows:

November 17—Oil and gas inspector, mapping wells in Oklahoma under Bureau of Mines, at $1,800 to $2,160 a year, and on well records, at $1,800 to $2,400 a year.

November 18—Junior explosives engineer in Bureau of Mines, Pittsburgh, Pa., at $1,200 to $1,500 a year.

December 1—Engineering inspector, oil and gas, in Oklahoma, under the Department of the Interior, at $2,160 to $3,300 a year.

Technical Associations

The November meeting of the New England Water Works Association will be held at Hotel Brunswick, Boston, Mass., November 11. The papers will be by Max von Recklinghausen on the sterilization of water with ultra-violet rays; by Sheppard T. Powell, on the use of ozone as a sterilizing agent for water purification, and by B. M. Wagner, on water rates. There will be a topical discussion on service pipes, led by E. C. Brooks and F. F. Forbes. Willard Kent, secretary, 715 Tremont Temple, Boston, Mass.

The fourth American Road Congress of the American Highway Association will be held in Atlanta, Ga., November 9-14. A. B. Fletcher, president, Sacramento, Cal.; I. S. Pennybacker, executive secretary, Colorado building, Washington, D. C.

The location of the exhibition of street cleaning appliances, to be held in New York under the auspices of J. T. Fetherston, commissioner of street cleaning, has again been changed to give sufficient room for the exhibitors, and will be held in the armory of the First Regiment Field Artillery, Broadway and Sixty-eighth street, Manhattan.

The American Road Builders' Association will hold its annual convention and road congress in Chicago, beginning December 14. The exhibit held in connection with the meeting is always a valuable feature.

The League of California Municipalities held its annual session at Monterey, beginning October 12.

The Society for Electrical Development has awarded thirteen prizes for stories presented in a recent competition, one being $250 to Roscoe E. Scott, of the National Lamp Works of the General Electric Company, Cleveland, Ohio; another of $150, to Don C. Shafer, of the General Electric Company, Schenectady, N. Y.; one of $50, to George S. Burdick, Scranton Electric Company, Scranton, Pa., and the others of $10 and $5 each.

The next convention of the Society for the Promotion of Engineering Education will be held at Iowa State College, Ames, Iowa, June 22 to 25, 1915, Dean A. Marston, of the College of Engineering, being president of the society.

The Municipal Engineers of the City of New York inspect the Hempstead aviation field, Garden City, L. I., on November 7, including the machines in the hangars and the aero motors, of which there are several in the machines. The society gives a trophy to the winner in a general efficiency test for altitude and speed.

The fire alarm system of New York was described to the Municipal Engineers of the City of New York by Putnam A. Bates, chief of the Bureau of Fire Alarm Telegraph, at their meeting on October 28.

At the meeting of the Cleveland Engineering Society on November 10, Ward Harrison, illuminating engineer, with the National Lamp Works of the General Electric Company, Cleveland, Ohio, will read a paper on "A New Era in Street Illumination."

Personal Notes

Joseph W. Goss has resigned as deputy city engineer of Sacramento, Cal., to accept the position of office engineer for the California State Highway Commission. Mr. Gross graduated in civil engineering from the University of California in 1907.

F. N. Holmquist, formerly city engineer of Phoenix, Ariz., has opened offices in the Noll building, 124 First avenue, Phoenix, as a civil engineer.

J. M. Slater has been appointed street commissioner of St. Louis, Mo., and will have charge of the repairing, cleaning and maintenance of streets, alleys, bridges, wharves and levees, the sprinkling of streets, collection and disposal of garbage and refuse, etc.

Robert E. Kremers has been appointed chief of the Bureau of Highways and Bridges of Portland, Ore.

Herman G. Farr has resigned as chief engineer of the Knox Motors Company and will open an office in Springfield, Mass., as consulting engineer. Mr. Farr is one of the best-known automobile engineers in the country and a pioneer of the industry, having, in conjunction with Harry A. Knox, designed one of the first successful gasoline cars in America. He has been with the Knox Company since it started fifteen years ago. His wide experience well fits him for his new work.

Publications Received

The Board of Street and Water Commissioners of Newark, N. J., has issued a synopsis of the bay front development and meadow reclamation project of the city, on which it has been authorized to spend $2,000,000. The city now has nearly 400,000 population and is rapidly growing, and needs the new dock and factory site facilities, ship channels, piers and railroad and transfer systems which this work will make possible.

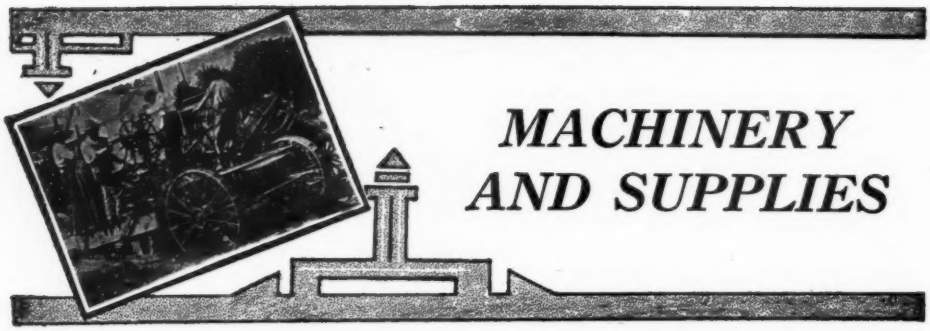
Report of the executive committee of the Municipal League on the Los Angeles city school department, October 13, 1914.

Strauss' Data Cards have now reached thirty-two in number. They are published at frequent intervals by H. A. Strauss, Harris Trust Building, Chicago, Ill.

A study of the Oxidation of Coal, by Horace C. Porter and O. C. Ralston, Technical Paper No. 65 of the Bureau of Mines, U. S. Department of the Interior.

"The Gate City of the Sunny South" is an enthusiastic appreciation of Atlanta, Ga., by Adolph M. Schwarz, an attorney of that city.

Bulletin General No. 425, of the University of Wisconsin, is from the extension division for aid in debating and public discussion, and gives a synopsis of arguments on both sides of these subjects with references to books and articles on them.



MACHINERY AND SUPPLIES

The Buckeye-Mobile

The Buckeye Engine Company, Salem, O., have developed a new engine which will develop a brake horse-power on less than 1.5 pounds of coal per hour.

Each unit is self-contained, boiler and engine being mounted together, and electric generator, if used, being immediately alongside.

The first unit installed is a 115-h.p. boiler and engine set in the basement of the works of the International Cork Company, Greenpoint, L. I., New York. The height from base to top of flywheel is 9 feet, length 17 feet 10 inches, requiring, in all, 32 feet 6 inches, including space required to remove tubes at head end and superheater at rear end, the space in front being required also for firing. The width is 7 feet 6 inches, and a generator with foundation adds 6 feet to the width, thus making 13 feet 6 inches by 32 feet 4 inches ground space and 9 feet height required for 115-h.p. output.

Several 225-h.p. units have been installed for the O. C. Barber Companies at Barberton and Canton, O.

Full descriptions of these engines and of the full line from 75 to 600-h.p. sizes will be found in Bulletin 111B and Special Bulletin No. 2 of the Buckeye Engine Company, Salem, O., who will send them on request.

Available Suggestions to Manufacturers

Naturally a company as conspicuous in industry as the Goodyear Tire and Rubber Company is a target for inventors of high and low degree. One of the duties of the experiment department of the company is to handle, pass upon and dispose of the thousands of suggestions that are presented, and all of which, their inventors believe, will revolutionize the tire business and bring wealth and happiness as the reward for originality. Letters and suggestions to Goodyear from inventors and others average three or four a day, all the year around. They come from all parts of the country and from foreign lands as well. Fully 25 per cent. of the suggestions have been proposed again and again by others. The head of the Goodyear experimental department has thus classified the ideas presented:

	Per ct.
Utterly worthless	55
Of value, but previously proposed	25
New ideas which might be successful, but which do not offer enough advantages to justify costly experiments	20
Ideas which we actually try, but which do not make good	4½
Actually accepted	½

That most of the suggestions come from persons of little experience or technical knowledge of the subject is no reason in itself for rejecting them. Sometimes such a person, having a broad perspective rather than an intimate knowledge, may hit upon very valuable ideas which the trained expert may entirely overlook. This department gives every idea sent in equally careful consideration, and, in judging the merits of a device, avoids the expression of personal opinion, but gets the facts of the case from the best authorities available.

Gypsum Products

The Red Book of the U. S. Gypsum Company is a mine of information regarding the building materials in which gypsum is used. It gives full information about the various grades and brands of gypsum plasters made and sold by this company, specifications for various work in which they can be used, methods of measuring areas and quantities required, etc. A considerable part of the booklet is devoted to Sackett plaster board, which takes the place of wooden lath, and Pyrobar gypsum tile, which can be used instead of clay tile for fire-proofing. Both these products are described at full length and their various uses are illus-

trated by text, drawings and photographs.

The book is well worth careful study, and can be obtained for the asking of the U. S. Gypsum Company at their Chicago office or at any of their branch plants, warehouses, stores or agencies.

Export Goods Must Be the Best

"In the wonderful opportunities that are opening up for the extension of our export trade thru the disorganization of foreign industries by the war, the American business man should not overlook the infinite importance of making permanent the advantages we may gain," says President George A. Kissel, of the Kissel Motor Car Company.

"This can be completely accomplished only by seeing to it that the products we ship abroad are the best that sound materials, skilled workmanship and careful supervision can make them.

"When demand is acute and quick delivery insistent, temptation is greatest to fill in with 'seconds' and 'shoddy.' But no American business man who has the future commercial welfare of his country at heart will yield to it, even tho his customer, in haste to receive the goods, is made cognizant of their defects.

"In short, everything that finds its way abroad with a U. S. label attached, or with a U. S. manufacturer as sponsor, should be so sterling a value that wherever it is shown and tested its superiority will be obvious.

"We recently filled an order for a large fleet of KisselKar trucks from the government of Greece. It was a time order, with a stiff penalty attached for every day of delay. Yet we did not accept this order until thoroughly satisfied that we could fill it without the sacrifice of a single detail of that same care and inspection taken with the most important domestic order. We look upon this method as a plain business duty, not only to the buyer, but to ourselves. We expect to keep on doing business in Greece—that is a reason sufficient in itself."

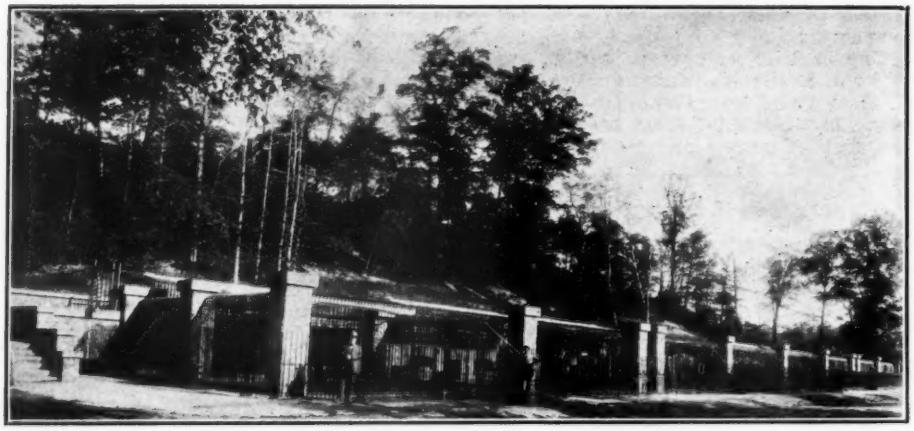
A Safe Fence For Bear Pit

One of the difficult designs for a park or zoo is the fence for the bear pit, as bears are able to surmount very difficult obstacles.

The accompanying photographs show a successful fence built for the Brookside Zoo of the city of Cleveland.

The work consisted of eight cages, requiring in all 800 feet of exceptionally heavy fence. This fence was made with ¾-inch square pickets with 2½-inch channel rails. The pickets were set diagonally in the rail and curved over at the top on an 18-inch radius. The ends of these pickets are forged to a sharp point and are reinforced with a 2½-inch angle. The main posts and wall are of nigger heads. The

BEAR PIT *fence which prevents the development of Bruin's strong propensities for climbing.*



BEAR PIT *at the Brookside Zoo, Cleveland, O., of specially handsome and safe design.*

intermediate posts for the interior fence are of 3-inch I-beams with forged sharp points. The posts extend into the ground about 4 feet and are set in concrete. The partition panels are constructed with every other picket curved in the opposite direction, so as to absolutely prevent the animals from climbing over the work. The gates in the exterior cages are of the swinging type and are so arranged as to close automatically.

The interior of the dens is very cleverly constructed, the arrangement of the doors being such that any part can be isolated at the will of the keeper. These doors are of the sliding variety and are also arranged that they are automatically closed or can be held open at the will of the operator. At the rear and top of the masonry is an additional barrier, constructed of ¾-inch square pickets, with 2½-inch channel rails, the pickets curved in at the top as on the balance of the work. This rail is securely fastened to the masonry by means of lead bolts.

Entirely surounding the cage work there is 1,600 feet of plain forged top fencing 5 feet in height. This fencing sets 4 feet away from the cage work and prevents spectators from annoying the animals. This fencing is constructed of ¾-inch square pickets with 2 by ⅝-inch channel rails. The pickets are spaced 5 inches center. The fencing is attached to the concrete sidewalk.

It is a well-known fact that bears are able to get out of almost any enclosure and it was the general impression that this cage work would have to be entirely covered over to prevent their escape. After one or two attempts the bears have made no further efforts to get out of these enclosures, and the idea of covering the top has been entirely abandoned.

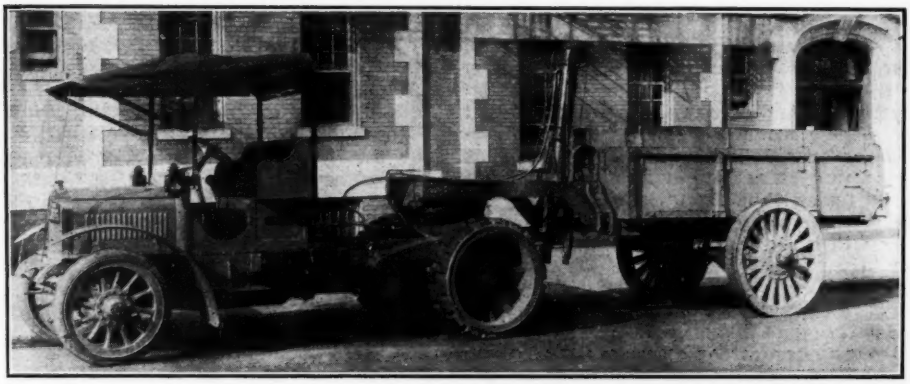
The work was designed by Stinchcomb & Boddy, landscape engineers, and was executed by the Van Dorn Iron Works Company, of Cleveland.

Special Five-Ton Saurer Tractor and Trailer For Handling Hot Asphalt and Contracting Material

This 5-ton Saurer tractor-trailer dump outfit, a product of the International Motor Company, has recently been placed in service by the Borough Asphalt Company, Brooklyn, N. Y.

This truck is used in connection with a special dump trailer, which is an innovation. The trailer body has a capacity of 5 tons, or 100 cubic feet, and is equipped with a Wood hydraulic hoist, dumping from the rear. It is unusual to mount an automatic dump mechanism on a trailer. The body is of wood 10 feet 6 inches long, 4 feet 6 inches wide at front; 5 feet wide at rear, 2 feet high, lined with sheet steel on the inside, with a ½-inch asbestos lining between the wood and steel sides, and is designed to carry hot asphalt, broken stone and sand. The dump mechanism of this trailer body is controlled from the driver's seat on the tractor, and raises the body 45 degrees. The oil pump for operating the hydraulic hoist is mounted on the driving shaft, and the fluid is forced back into the hoist on the trailer thru flexible pipe connections.

Most trailers have the dump arrangement at the bottom, but for a number of reasons it is not advisable to handle hot asphalt in this manner. There would be considerable disadvantage in closing the dump opening if hot asphalt was dumped



FIVE-TON AUTOMOBILE TRUCK, *with trailer, for hauling asphalt mixture to the street for laying, operated by the Borough Asphalt Co., New York. Note rear dump by means of the mechanism at front of the dumping body.*

thru the bottom, owing to the clinging nature of this substance, which prevents tight closing. It is necessary to have a very tight body for transporting hot asphalt, as it is handled at a temperature of 300 degrees and must be kept hot until worked into position on the street.

The Borough Asphalt Company are very active in the use of tractors and trailers in their paving and road construction work, and are getting fine results from their Saurer tractors, of which they now have seven.

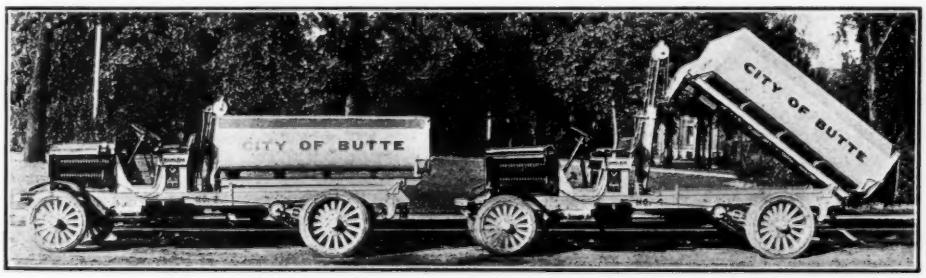
Trailer outfits of this nature give greater flexibility of operation and permit heavy loads to be handled in rugged service where it would not be possible for a truck with a capacity load to pull out.

Important in this Saurer tractor-trailer construction is the universal coupling which links the two units together. This connection is by a type of "fifth wheel," which the International Motor Company is using with great success, and which permits quick attaching and demounting.

The wheel base of the Saurer tractor is 10 feet 8 inches.

Exclusive of the Saurer chassis, cost of the trailer outfit complete, including "fifth wheel," hydraulic hoist and pipe connections, body, frame and trailer wheels, is $1,200.

KISSELKAR *gravel trucks of the city of Butte, Mont., of 3½ tons capacity.*



Kissel Trucks Carry Overload Regularly

Two Kissel trucks, 5-ton capacity, were operated under a 20 per cent. daily overload on a long haul for over a year. They each brought two 6-ton loads of lumber per day from the yards at the port of Wilmington to the city yards of Ganahl Lumber Co., or to a job in progress. This involved more than 80 miles a day, one way empty, the other under overload.

Automatic Sprinklers for Fire Protection

One of the approved systems for fire protection is the Evans system of sprinkler heads, dry valves and alarm valves made by the Merchant and Evans

Co., Philadelphia, Pa. To meet all needs of those wanting this most effective method of protecting goods from fire, whether in fireproof buildings or not, the Merchant and Evans Co. have developed a selling system which gives the purchaser every opportunity to obtain what he wants at a minimum of cost and on easy terms, thus they will sell the sprinklers outright for installation by the owner; will make the installations themselves or thru their accredited licensees at prices bid; or on a basis of cost plus a percentage; or will make full surveys, drawings and plans for reasonable engineering charges for opening the work to competitive bids; or will exchange for old heads in use, making the best current allowance for the old material.

A Refrigerator Motor Truck for Dairy Products

A 1,500-pound KisselKar owned by the Edgewood Farms, of Newport, Minn., and made by the Kissel Motor Car Company, of Hartford, Wis., is equipped with a refrigerator which insures keeping cool and sanitary the bottled milk and milk in cans which this truck carries. The body is of the panel type and is constructed of sheet steel and besides being very rigid, is of pleasing lines, the top being carried forward over the driver's seat in a slight curve.

The body has four doors, a double door being provided at the rear and a single door large enough to permit of the loading of the standard 10-gallon milk can on each side, directly to the rear of the driver's seat. Besides being used for loading and unloading the 10-gallon cans of milk, these side doors are also used to remove bottled milk, butter and cheese, which are carried on shelves directly below the refrigerator, which is attached to the forward end of the body.

The refrigerator is positioned directly beneath the roof. It is supported by uprights at its rear side, which also act as supports for the shelves which are placed beneath the refrigerator. The latter is zinc-lined and as a further protection against radiation is enclosed on all sides within several inches of charcoal. Its capacity is 300 pounds of ice. The water resulting from the melting of the ice in the refrigerator is drained off thru a small pipe which extends downward from the bottom of the refrigerator in back of the shelves and thru the floor of the body to within a foot of the ground.

The shelves for carrying the bottled milk and butter are six in number and are placed one above the other beneath the bottom of the ice box. Besides the air cooled by direct contact with the refrigerator, these shelves are also cooled by the cold water passing down thru the refrigerator drain pipe to the ground.

The outside appearance of the body is very pleasing to the eye, it being painted with white enamel, highly polished, and the name of the owner painted in gold letters.

The inside length of the body is 8 feet, and the inside height, measured on the center line, is 5 feet and 6 inches.

Wire-Cut-Lug Brick Has Phenomenal Popularity

In the five seasons beginning in 1910 and ending with October 1, 1914, covering not much more than four years of time, the development of the use of wire-cut-lug blocks has been so phenomenal that the total distribution of the blocks now amounts to 151,316,534. The progress in road and street building in the various states, influenced to some extent by the relative sizes of the states, is shown by the following table, giving the number of wire-cut-lug blocks distributed to each state:

New York	65,903,876
Ohio	36,149,271
Illinois	16,429,290
Pennsylvania	10,246,337
Maryland	6,320,300
Indiana	5,960,110
Canada	2,914,200
Kentucky	1,816,300
Michigan	1,543,700
North Carolina	973,350
New Jersey	886,500
West Virginia	634,300
Florida	479,800
Tennessee	366,000
Georgia	356,400
South Carolina	320,400
Wisconsin	7,400
Connecticut	5,000
Virginia	4,000

Concrete Mixer Earns Large Bonus in South America

The specifications for the installation of weighing equipment for the government of Uruguay at the port of Montevideo provided that the furnishers of the weighing equipment had to make delivery and to have erected all the equipment within three months. The contract also contained a proviso that a bonus of $5.00 per day per weighing device was to be paid in which the specified date of completion was anticipated, and a like penalty forfeited for every day beyond the specified date for completion of contract.

It required about six weeks to transport the equipment, materials had to be as-

sembled, pits had to be dug and foundations laid before any of the weighing equipment could be installed. The work had to be done with the utmost care, since the entire imports and exports of Uruguay, amounting to $85,000,000, pass thru this port, and all must be weighed.

The "Standard" concrete mixer was used and was ready to run onto the job upon its arrival, as they are completely assembled ready for operation when they leave the factory.

The drums are charged low at the base, so that direct charging from the barrows saves the need of having a loading skip. The point of charging is only 24 inches above the ground. The Standard Scale and Supply Co., Pittsburg, are the makers of the line of mixers.

Asbestos Expansion Joint

The H. W. Johns-Manville Co. is manufacturing an expansion joint felt of asphalted fiber containing asbestos, which can be used with success in filling the expansion joints in concrete, brick and wooden block pavements. It is made in ¼ and ⅛-inch thicknesses and has been in use long enough to demonstrate its value and durability. Asbestos is not decomposed by age.

Motor and Bicycle Tire Business is Increasing

Today desirable publicity regarding motor vehicle tires has more value when based on actual use and service. For that reason there is interest in the tire census taken by *Rider and Driver* of the 3,159 cars gathered at the opening of the Belmont Park race track last spring. This was naturally a showing of big cars, automobiles of the most expensive makes, and the tire equipment indicated, in a way, the preference of those who are more interested in tire service than in the cost of the tires themselves. Every tire was tabulated in the paper's count, spares included, a total of 16,006. It so happened that in this select aggregation Goodyear led its nearest competitor by 198 tires, and had approximately fourteen per cent. of the total equipment, divided among thirty makes.

This year three out of every four motorcycles are Goodyear equipped. The same proportion will continue in 1915. The company gives six strong reasons for this: Goodyear tires will have stronger beads than ever before. They will have gum strips between plies at the splices, same as Goodyear automobile tires. A still more durable tread stock has been evolved for the '15 product. The feather edge of the flap has been perfected. Every Goodyear tube will carry a valve spreader, and the tubes themselves will be heavier than ever before.

But one style of bicycle tire will be made, the best. And more bicycles are in use this year than ever before. The business has been increasing annually until it is approaching the phenomenal production of the years when bicycling was most popular.

Taxicab Test of Tires

The Terminal Taxicab Company, of Washington, purchased twenty-one 34x4-inch Goodrich safety tread tires last January, and kept complete records on service delivered by these tires.

A report of detailed figures shows that these twenty-one tires had averaged 5,707.9 miles up to and including June 16, and that nine of them at that time were still in service and delivering even greater mileage than this high average.

The continuous starting and stopping of a taxicab during the day's activity is the hardest and roughest service to which a tire can be subjected. In fact, the taxicab test is the supreme test for any tire and the showing made by Goodrich safety treads in this severe day-to-day grind is further proof of the mileage and service delivered by the safety tread construction.

It is the five-bars and cross-tie, tough rubber fingers which grip the road at the same time that they deliver extra wear, which are accountable for Goodrich safety tread extra mileage, as shown at Washington.

Domestic Refuse Destructor

The Atkinson-Morse Destructor Co., 30 Church street, New York, make and install a small refuse destructor for the use of hospitals and similar institutions, and for use in private estates, summer homes and camps, where the output of waste is not sufficiently large to warrant the maintenance of a continuous fire.

It is cylindrical in form, about 5 feet high by 2 feet in diameter, made of steel casing with cast iron base and top, with doors for charging the waste and fuel, and removing ashes. The lower section carries a cast iron shaking and dumping grate on which the initial coal or wood fire is made, and where the combustion of material takes place.

The whole interior is lined with the most refractory firebrick and provided with a special series of transverse fireclay bars thru which the smoke and the gases must pass and are consumed by contact with the highly heated firebrick surface. In the dome can be placed a coil for heat-

ing water which will be equal to providing from 100 to 200 gallons of hot water per hour.

The apparatus is strong and durable, can be operated by any person with the minimum of attention, can be connected, when set in the cellar of a building, with the chimney-flue of any house, or, when used out of doors, must be provided with a vertical smoke pipe 7 to 8 inches in diameter and from 30 to 40 feet in height. In this case there should also be a small covering house to protect the furnace from the effects of the weather.

Evidence as to Pavements

Several million yards of Trinidad and Bermudez sheet asphalt pavements that have given a service of twenty years or more are illustrated and described in a booklet entitled "Evidence," published by The Barber Asphalt Paving Company. A score of cities are represented and wherever maintenance data were obtainable they have been given, along with the date the pavement was laid, and a photograph showing its present condition. The oldest of the pavements so described is the Trinidad sheet asphalt pavement on Vermont avenue, Washington, D. C. It is thirty-five years old. Something more than 1,000,000 square yards of asphalt paving in Washington, D. C., averaging twenty-three years of age, has cost 1.8 cents per yard per year for maintenance. New Orleans has several thirty-year-old pavements. Buffalo has 1,200,800 yards of sheet asphalt twenty years of age or more and still in use. Among other cities that contribute to the census of more-than-twenty-year-old pavements are New York, Philadelphia, Boston, Chicago, St. Louis, Cincinnati, Columbus, Detroit, Omaha, Charleston, S. C., Savannah and Louisville.

Trade Notes

The C. & C. Electric & Mfg. Co., of Garwood, N. J., manufacturers of electric motors, generators and electric-arc welding equipment, announce the removal of their Detroit offices from 144 Seyburn Ave., to 1111 Chamber of Commerce Bldg. This office is in charge of R. K. Slaymaker. A new branch sales office in the Security building, Minneapolis, Minn., has been put in charge of R. L. Wells.

Concrete piles for the foundations of the New York American Building; loft building for Mullins Bros.; for the new elevated structure in connection with the subway extension at Long Island City, in New York City; for the Steuart-Knatz warehouse, Baltimore, Md.; for the foundation of the Division pumping station, Cleveland, O.; of East Kansas avenue bridge, Kansas City, Kans., and office building for the East Ohio Gas Company, Cleveland, O., will be furnished by the Raymond Concrete Pile Company.

The prospects for the Panama-Pacific International Exhibition, to be held in San Francisco in 1915, are for prompt opening, with exhibits practically in place. A recent recital of the exhibits actually on the way shows that the countries of the world will be very generally represented and that the war does not affect the number and kind of exhibits except from a small area in Europe.

The MacArthur Concrete Pile and Foundation Company will furnish concrete piling for the foundations of the Firemen's Fund Insurance Company's building, San Francisco, Cal.; of the one-half million cubic-foot gas holder of the Empire Gas and Electric Company, Auburn, N. Y.; of the new warehouse of the American Dock Company, at Tompkinsville, Staten Island, N. Y.; for the Canadian Kodak Company's new power plant and boiler house, at Mt. Dennis, a suburb of Toronto, Ont.; for the First Congregational Church, Toledo, O.

The Merritt Hydraulics Company, Philadelphia, Pa., have the rights under the new patents on the Priestman natural compound pumping system for screening sewage and by-passing the screenings and pumping the finely screened sewage by high efficiency centrifugal or displacement pumps.

Trade Publications

The Kansas City Testing Laboratory, Kansas City, Mo., has issued Bulletin No. 7, which gives definitions and tables of equivalents of weights and measures, which is sold at 25 cents.

"Defeating Rust—The Story of Armco Iron," "Iron Roofs That Resist Rust" and "A Journey to Armco Farm" are the titles of three new publications on "Armco" products recently issued by the American Rolling Mill Co., of Middletown, O. In the booklet on the story of "Armco" iron are shown many illustrations of "Armco" iron used for roofs, ventilators, gutters, lath, window frames, stoves, refrigerators, culverts, pipes, etc. The booklet entitled "Iron Roofs That Resist Rust contains an article on why iron roofs resist rust and illustrations and descriptions of many forms of "Armco" iron used in roof construction. Rules for estimating amount of corrugated iron required to cover given spaces, tables of weights and list of products manufactured of "Armo" iron are also given in the booklet. "A Journey to Armco Farm" contains an interesting story of the various uses to which "Armco" iron is put.